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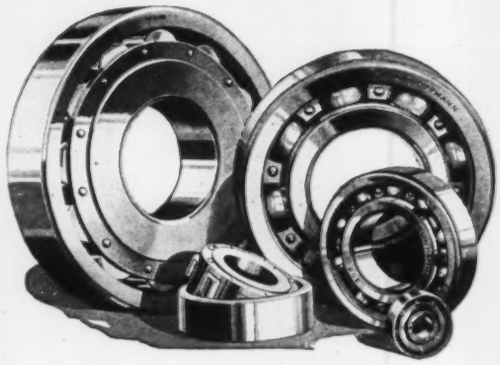
DECEMBER 1930

MACHINE DESIGN

AS IT AFFECTS

ENGINEERING-PRODUCTION-SALES

PRECISION



FOR BETTER PERFORMANCE

In comparing values, performance should be the determining factor. It is the only true test of worth—gauged not by first cost, but by ultimate cost over a useful life. It is the standard by which true economy must be measured.

In every field of engineering and industry, over a period of twenty years, NORMA-HOFFMANN Precision Bearings have made a distinguished record for dependable stand-up-ability. For greater economy, longer sustained, they stand pre-eminent.

There is a PRECISION Bearing for every load, speed and duty. Let our engineers help you select the type best adapted to your special conditions. And write for the Catalogs.

NORMA-HOFFMANN BEARINGS CORPORATION
STAMFORD CONN., U.S.A.

"NORMA-HOFFMANN"
PRECISION BEARINGS

OPEN TYPE BALL BEARING

CLOSED TYPE BALL BEARING

SINGLE ROW SELF-ALIGNING BALL BEARING

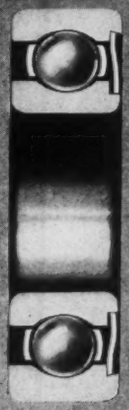
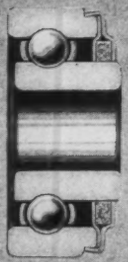
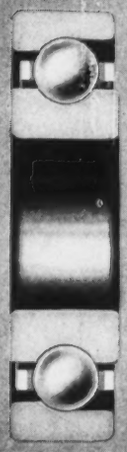


PLATE TYPE BALL BEARING

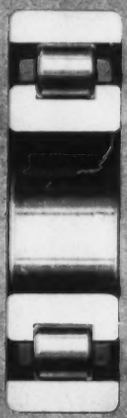


"GREASEAL" BALL BEARING

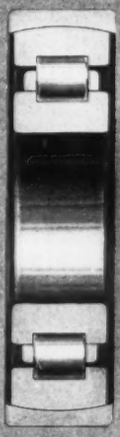
DOUBLE ROW SELF-ALIGNING BALL BEARING



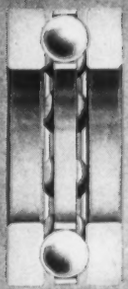
ANGULAR CONTACT BALL BEARING



STANDARD ROLLER BEARING



SELF-ALIGNING ROLLER BEARING



BALL THRUST BEARING

BEARINGS

An INNOVATION *in Variable Speed Transmission*

For more than three years Link-Belt has been testing in practical service an entirely new type of variable speed transmission, the P.I.V. Gear. It is now on the market, and becomes a new unit in Link-Belt's comprehensive line of Positive Drives.

The Link-Belt P.I.V. Gear is unique in that it is the first variable speed device in which the power is transmitted from the input to the output shaft through a positive chain drive.

Link-Belt now builds the P.I.V. Gear in five standard sizes, from 1 to 10 H.P. capacity, providing speed change ratios up to a maximum of 6 to 1. Full details are in new book No. 1274.

LINK-BELT COMPANY

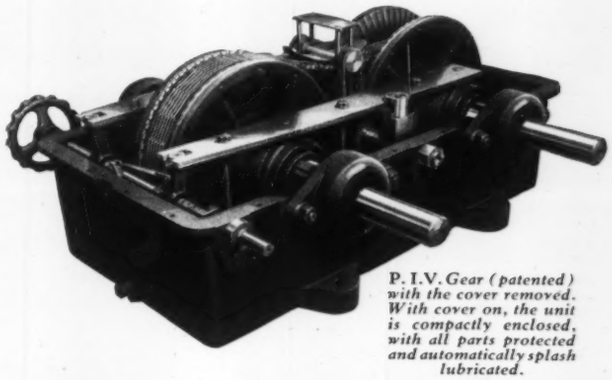
Leading Manufacturers of Positive Power Transmitting Equipment

CHICAGO, 300 W. Pershing Rd. INDIANAPOLIS, 501 N. Holmes Ave.

PHILADELPHIA, 2045 W. Hunting Park Avenue

Offices in Principal Cities

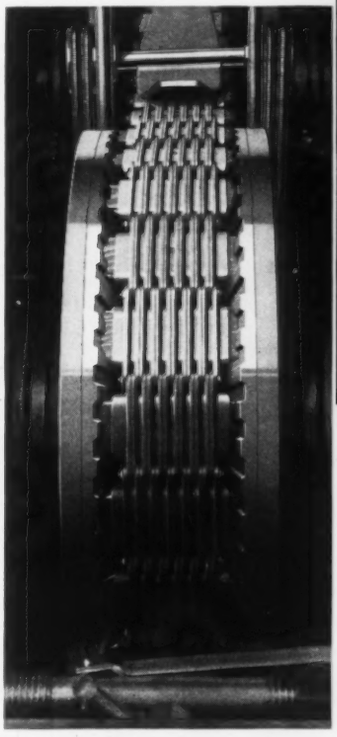
4144

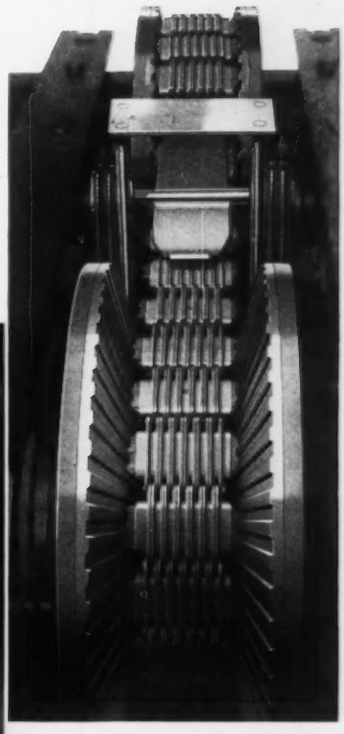


P.I.V. Gear (patented) with the cover removed. With cover on, the unit is compactly enclosed, with all parts protected and automatically splash lubricated.

Right: *Tooth formation of the P.I.V. Chain on the minimum diameter of a wheel (a pair of discs).*

Lower: *Tooth formation of the P.I.V. Chain on the maximum diameter of a wheel (a pair of discs).*





Link-Belt makes a Positive Drive for every class of power transmission service. These drives include:

Silent Chain Drives
Roller Chain Drives
Herringbone Gear Speed Reducers
Herringbone Gears
Worm Gear Speed Reducers
Malleable Iron and Steel Chain Drives

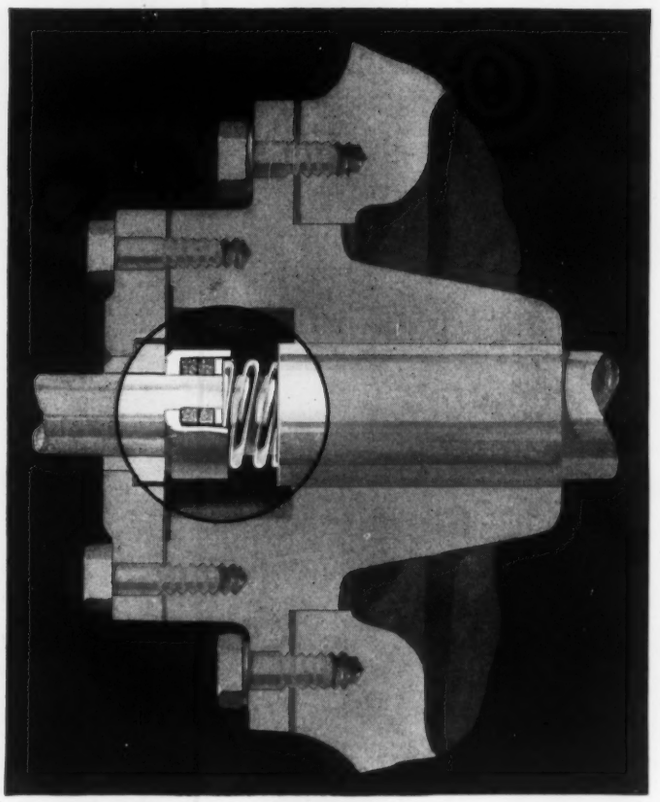
Send for Catalogs

THE LINK-BELT P.I.V. GEAR

• • POSITIVE INFINITELY VARIABLE • •

See the P. I. V. Gear at our Exhibit at the Chicago Power Show, Feb. 10 to 14, 1931

What It Does For Others It Can Do For You



Showing a typical application of Cooke Seal to the crankshaft of a domestic electric refrigerator

The recent rapid growth of domestic electric refrigeration has been effected largely through the elimination of leaking refrigerant. In this successful conquering of a difficult "bug" Cooke seals have played an important part. On forty or more famous electric refrigerators they are today standard equipment. New machines are being designed to take Cooke Seal Rings exclusively and still others are changing over. Leaks, thanks to Cooke, can now be a thing of the past.

In a hundred other fields Cooke is solving packing problems, helping to make good machines better. If your product has a shaft revolving through a stationary housing, you can eliminate leakage, decrease service costs, motor load and wear on shaft with a Cooke Seal Ring.

It will not leak. No other type of packing or seal around a revolving shaft can even begin to equal its performance. Because the Cooke Ring is a *mechanical* device, revolving *with* the shaft, forming a leak-proof ground joint against the gland face or housing through which the shaft revolves, reducing friction and wear and thus saving dollars and trouble for both maker and user.

It is leak-proof against liquid or gas, however volatile, at any pressure. It is also used for deep and continuous vacuums. Its price is minor, its installation cost is little.

By all means, use the coupon today

COOKE Seal Ring

10 North Green Street, Dept. G, Chicago, Illinois

ROTATES WITH

Cooke Seal Ring, Dept. G
10 North Green St., Chicago

Please send me your FREE booklet without obligation.

Name..... Address.....

City..... State.....

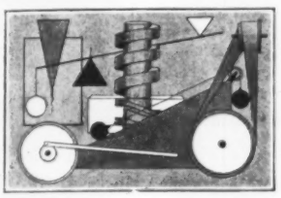
THE SHAFT

MACHINE DESIGN

as it affects

ENGINEERING–PRODUCTION–SALES

Volume 2 | **December, 1930** | **Number 12**



Forthcoming ISSUES

AMONG high spots in design of machinery during the past year has been the tremendous advance made in application of photoelectric equipment. For this reason MACHINE DESIGN *plans to publish in an early issue an authoritative article on this subject.*

The contribution will not be merely a review of the new applications made during the year but rather will give, besides interesting and pertinent information on the utilization of the photoelectric cell, numerous important and specific examples of successful applications made to various types of mechanical equipment.

Further data on this unique apparatus will appear in later issues.

L. E. Jermy.

Managing Editor

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How Long *Must* They Be?...

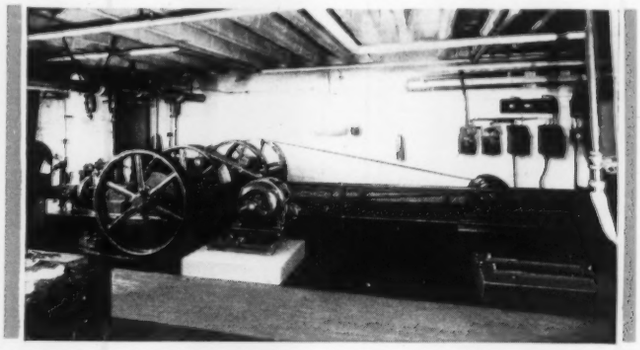
FLAT BELT DRIVES

...How Short *Can* They Be?

"ABE" LINCOLN, when asked by a wag how long a man's legs should be, answered: "Long enough to reach from the seat of his trousers to the ground!" . . . The same sensible rule applies to the length of flat belt drives—they should be as long or can be as short as the need demands.

In the days of steam power, when line shafts were used to distribute power throughout a plant, every condition encouraged the use of *long* belts.

But times have changed! Steam power has been replaced by electricity. The trend of the times is to replace main line shafts with small group and individual motor-drives. The increasing cost of factory space calls for compact layouts both of machines and of drives . . . In many cases it is desirable that the machinery builder incorporate motor and drive as a part of the machine.

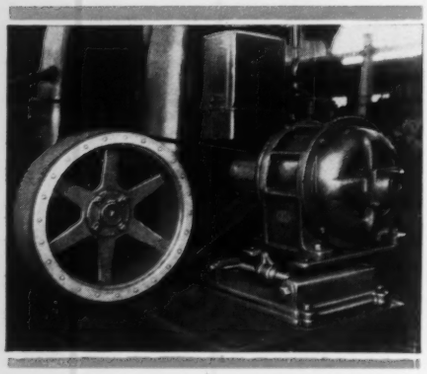


An example of the *old* and the *modern*—two refrigeration units in a Boston apartment house. Each drive originally required 15 feet of space between shaft centers The front drive, furnished by ROCKWOOD, requires only 3 feet, a saving of 80% in belt length . . . Because of proved economy, conservation of space and superior performance, a drive for the rear unit, identical with that of the front, has been installed since this photograph was made.

• • •

Despite these changing requirements, many engineers and designers still think of the flat belt as being limited to *long* drives. And seizing this opportunity, builders of later drives—*more expensive* in cost, *more complicated* in maintenance, yet *less efficient* in performance—are creating the false impression that their new drives are a *necessity* for short-center applications.

As a matter of fact, the flat belt drive is adaptable for *extreme compactness*. It will save space down to the last possible inch, at the same time retaining all the advantages of simplicity and economy, ease of installation and maintenance, high efficiency and dependability, which *no other* type of drive equals.



A compact flat belt drive replacing noisy and inefficient gears . . . Motor, 7½ H.P. at 900 R P.M. . . . 1 to 4 speed ratio . . . 24-inch shaft centers.

• • •

ROCKWOOD engineers have developed and perfected such a drive—a flat belt drive that out-performs all other types of short-center drives, whether of gears, chains or V-belts. Already it is being endorsed by many leading power transmission authorities.

Now in daily use on hundreds of difficult machine applications, already adopted as standard equipment by several progressive machinery builders, this ROCKWOOD short-center drive—for use with efficient ROCKWOOD Pulleys—will soon be available in all leading cities in a range of standard stock units from 1 to 50 H. P. It is as easy to install as an electric motor!

. . . It's time to forget the old notion that flat belt drives *must be long*. ROCKWOOD has *proved* that they can be *as short as you want them!* It's time to investigate the important advancements that ROCKWOOD engineers have pioneered in this field. Write today!

THE ROCKWOOD MANUFACTURING CO., INDIANAPOLIS, IND.
THE OHIO VALLEY PULLEY WORKS, MAYSVILLE, KENTUCKY
Divisions of General Fibre Products, Inc.

ROCKWOOD

PULLEYS THAT PULL

Itemized Index, December, 1930

Key: Edit, Editorial Pages; Adv, Advertising Pages; R, Right hand column; L, Left hand column

Compiled for the assistance of engineers confronted with specific design problems

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THE next issue of Machine Design begins Volume III. With the beginning of another volume, the indexes for the one just completed will be ready for distribution. In addition to the usual combined contents index, covering the twelve issues of the year, the issues August through December will be covered by an itemized index, combined for these months.

If you have not already notified the circulation department to put your name on the list to receive the Index each year as it is published, it would be well to do so now. A copy of the 1929 contents index will be included if you'd like one.

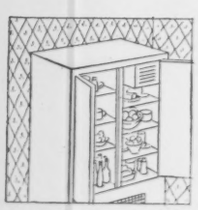
14 leaders cooperated *in preparing this book* for you

Presents facts and figures on fastening methods which have proved particularly advantageous.

TO help you attain greater fastening economy this interesting and informative booklet has just been published. It was prepared with the cooperation of fourteen of the most prominent manufacturers in their respective fields, who permitted a nationally known firm of engineers to enter their plants and make studies of fastening methods which have proved particularly advantageous.

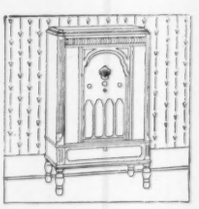
Certified facts and figures from those studies make up the booklet. Every production executive who is interested in attaining faster, easier, more economical assembly of a product made wholly or partly of metal should read with great interest such accounts as:

Servel saves $64,120 a year . . .



by assembling the exterior metal sheathing of their refrigerator cabinets with Hardened Self-tapping Sheet Metal Screws. This story of fastening economy is told by one of Servel's engineers, who describes the former methods of making the assembly, as well as the present method which eliminates a skeleton frame-work of wood with a saving of $1.00 per cabinet.

44 tapping operations eliminated on Philco Radio



by fastening parts to the chassis with Hardened Self-tapping Sheet Metal Screws. The details of this achievement are particularly interesting since few products require more assembly work than a radio receiver. This report also explains the severe tests by which Philco determines the security of a fastening.

50% saving made by Doehler . . .

through the use of Self-tapping Screws on both vending machine and metal furniture assemblies. In this fastening study, the Chief Engineer of Doehler Die Casting Co. discusses alternative methods of fastening to die castings and of assembling sheet metal.

Enormous savings effected in auto production . . .

where fastening devices are selected with utmost care. That such effort pays, is proved by an account of the way a great builder of auto bodies saved $150,000 in a year by using Self-tapping Sheet Metal Screws for making fastenings to sheet metal.

Every study is worth reading!

All of the fastening studies in this book are interesting. Other contributors include: Zenith-Detroit, Gilbert and Barker, Stout, Edison and Simmons.

Any plant executive concerned with design or production may obtain "Fastenings" by using the coupon.

THIS COUPON BRINGS YOUR COPY *FREE!*

Parker-Kalon Corporation, 202 Varick Street, New York, N. Y.

Send a free copy of "Fastenings" marked to the personal attention of:

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TOUGH-RIGID-STRONG-WEAR RESISTING CAST STEEL

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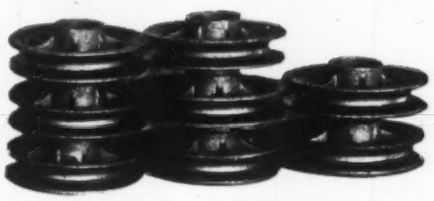
CLEVISES



SHEAVE WHEELS

CONVEYOR ROLLERS

The Modern Trend . . .

THE modern trend throughout the great industries of today is toward "greater service" steel castings.

Castings are specified with the maximum in physical properties, surface smoothness, solidity, trueness to design, correctness in coring and ultimate service life.

Engineers discriminate in their choice. They want strength to reduce sections and increase rigidness. They want toughness and ample ductility to resist shock. For long life they look for ability to resist wear.

Farrell's 85 is just the steel to enable engineers to fit parts to their jobs. It is obtainable in Grades H, HH, A, B and C, which lend a wide range of applications where strength, rigidity, toughness, wear resistance, or a combination of all these qualities is imperative and sought for.

SPECIFY IT! • DEMAND IT! USE IT!

FARRELL-CHEEK STEEL FOUNDRY COMPANY, SANDUSKY, OHIO

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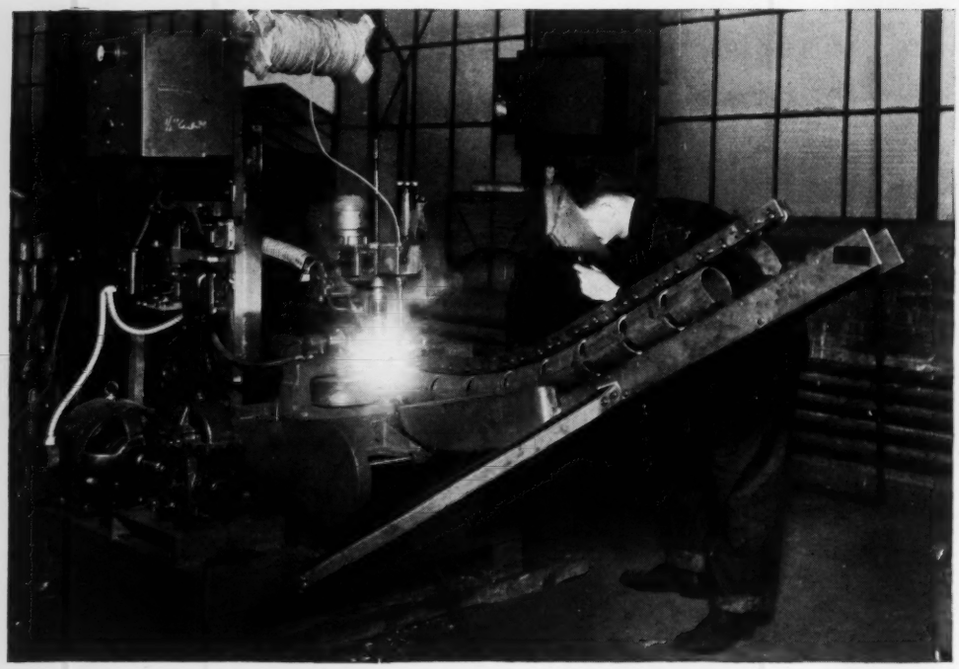
DULUTH OFFICE—518 Providence Bldg.—Phone: Melrose 1095-J
ST. LOUIS OFFICE—907 Security Bldg.—Phone: Garfield 5222
DENVER OFFICE—3417 E. 14th Avenue

FARRELL-CHEEK



★ Automatically welding automobile starter and generator frames by the Lincoln Electronic Tornado process, which utilizes the shielded arc. Below is shown a generator frame after welding.

PROGRESS

TRADITION

"WHAT a boost we could give to the automotive industry if we could only bring about an improvement as great as the self-starter . . . "

•

"All right, and if we can't improve the auto we can at least improve its production. I'll show you a case right in that self-starter field where they did just that by means of the 'Electronic Tornado' process.

By utilizing Lincoln's shielded arc for the production of starter and generator frames they now pop them out at the rate of *240 per hour.*

Formerly they used seamless tubing. Now they use 5/16″ and 3/8″ steel plate formed into shape and butt welded automatically.

And, Pop, there are other automotive products, automatically welded by the 'Electronic Tornado's' shielded arc, such as torque tubes, brake cross shafts, rear axle housings, wire and disc wheels and other parts.

Pipe, tanks, machinery parts, boilers, safes, battleship deck type of steel floors and grave vaults are a few of the products the 'Electronic Tornado' welds in other industries.

And this little idea on automatic production (see illustration) has brought to the manufacturer the same convenience as the starter brought to the driver . . . with this exception: the driver can't make *240 per hour* and live at home."

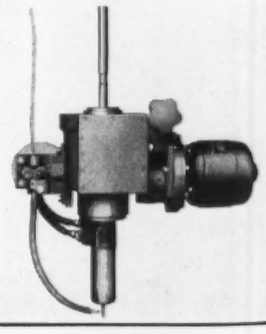
•

THE LINCOLN ELECTRIC COMPANY
Department No. 37 12 Cleveland, Ohio
World's Largest Manufacturers of Arc Welding Equipment

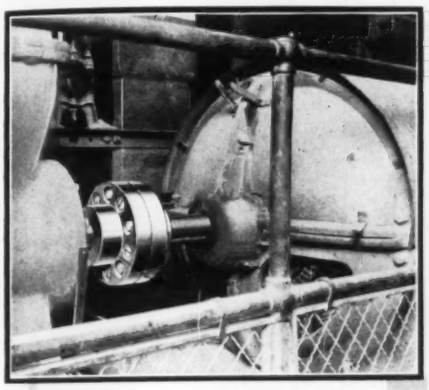
W-168

LINCOLN "Stable-Arc" WELDER

The Lincoln Electronic Tornado automatic welding head equipped with fibrous autogenizer feed.



Ajax Couplings Most Universally Used



No one type of flexible coupling is suitable for all driving purposes. Ajax, however, has a wider range of application than most types because of its simple construction and fair price.

Standard sizes are made for ¾" to 12" shafts. Special sizes and designs are quickly made to order. Ajax Rubber Bushed Flexible Couplings have been applied with outstanding success in the larger sizes. They are also widely used in the smaller sizes, particularly by pump, speed reducer and special machinery manufacturers who buy large quantities of a few sizes and who want a quality heavy duty drive at low cost.

The simple Ajax construction—live rubber bumpers; bronze oil-less bushings; hardened and ground steel pins; and two identical, interchangeable, semi-steel flanges—is ample reason for its wide use and profitable application.

Cheap "rubber bumper" type couplings do not compare with Ajax in any respect—Ajax improved this type of coupling, and is still the quality manufacturer of rubber bumper couplings. Regardless of your requirements, investigate Ajax before you buy. It will mean time and money saved. Write for Bulletin No. 13.

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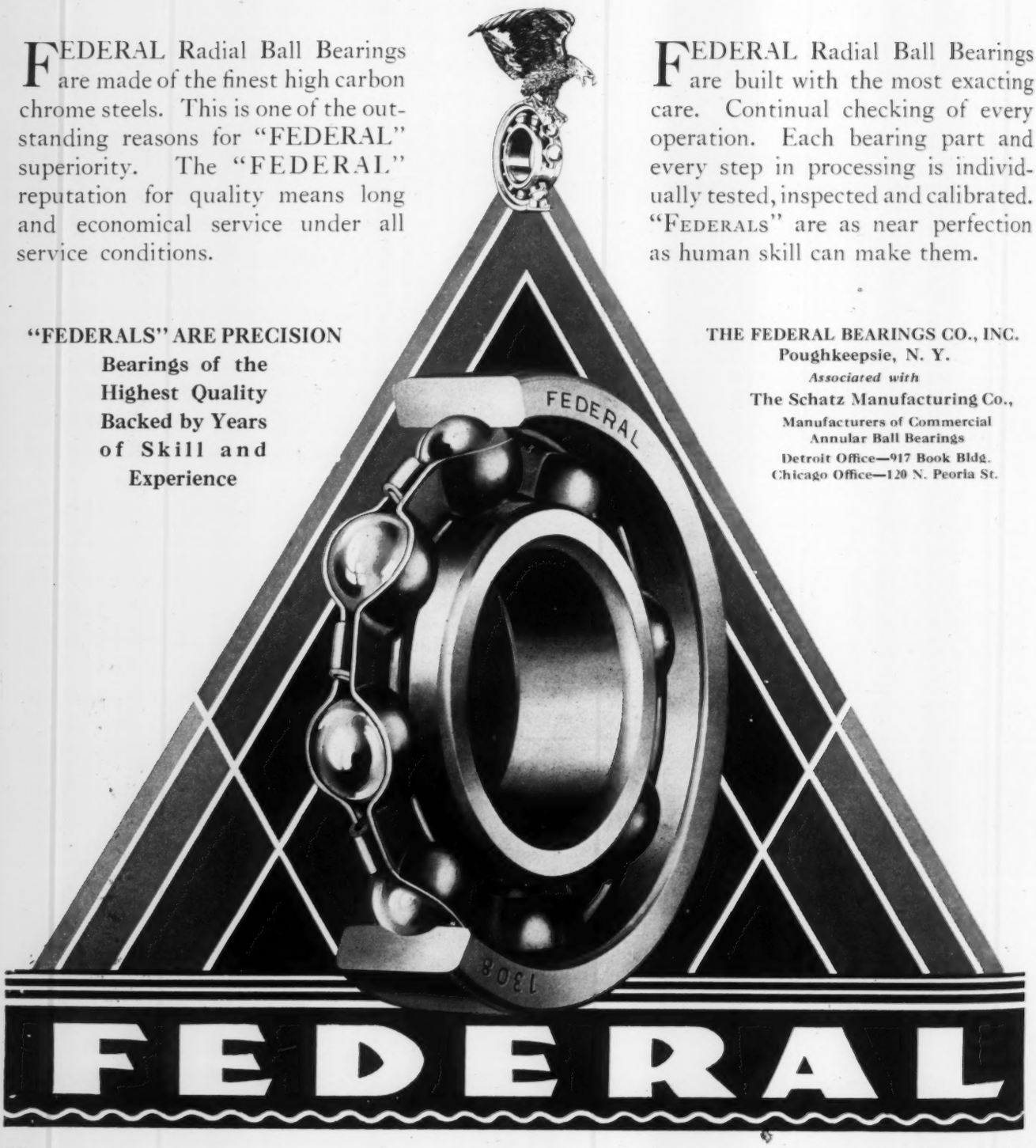

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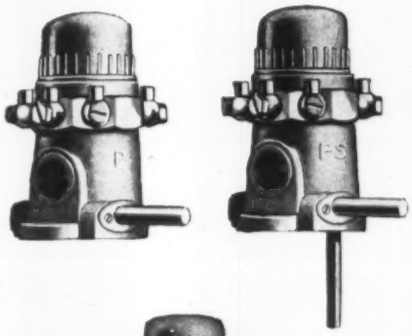

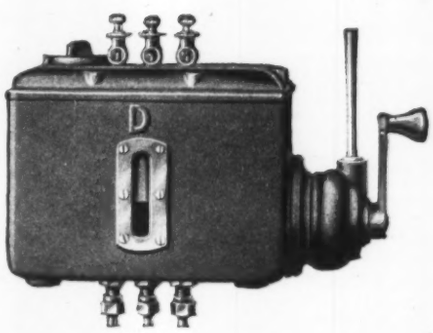

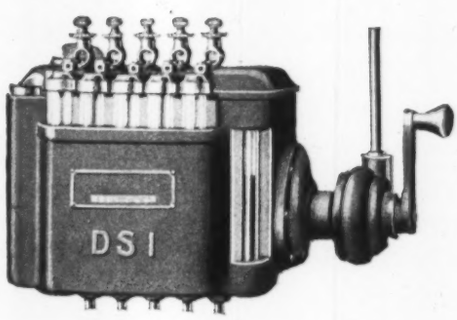

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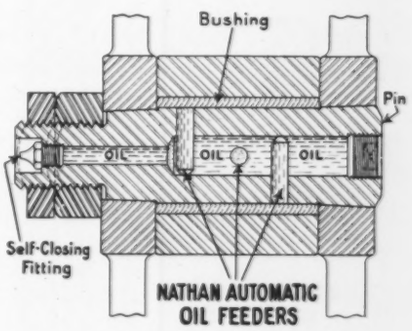

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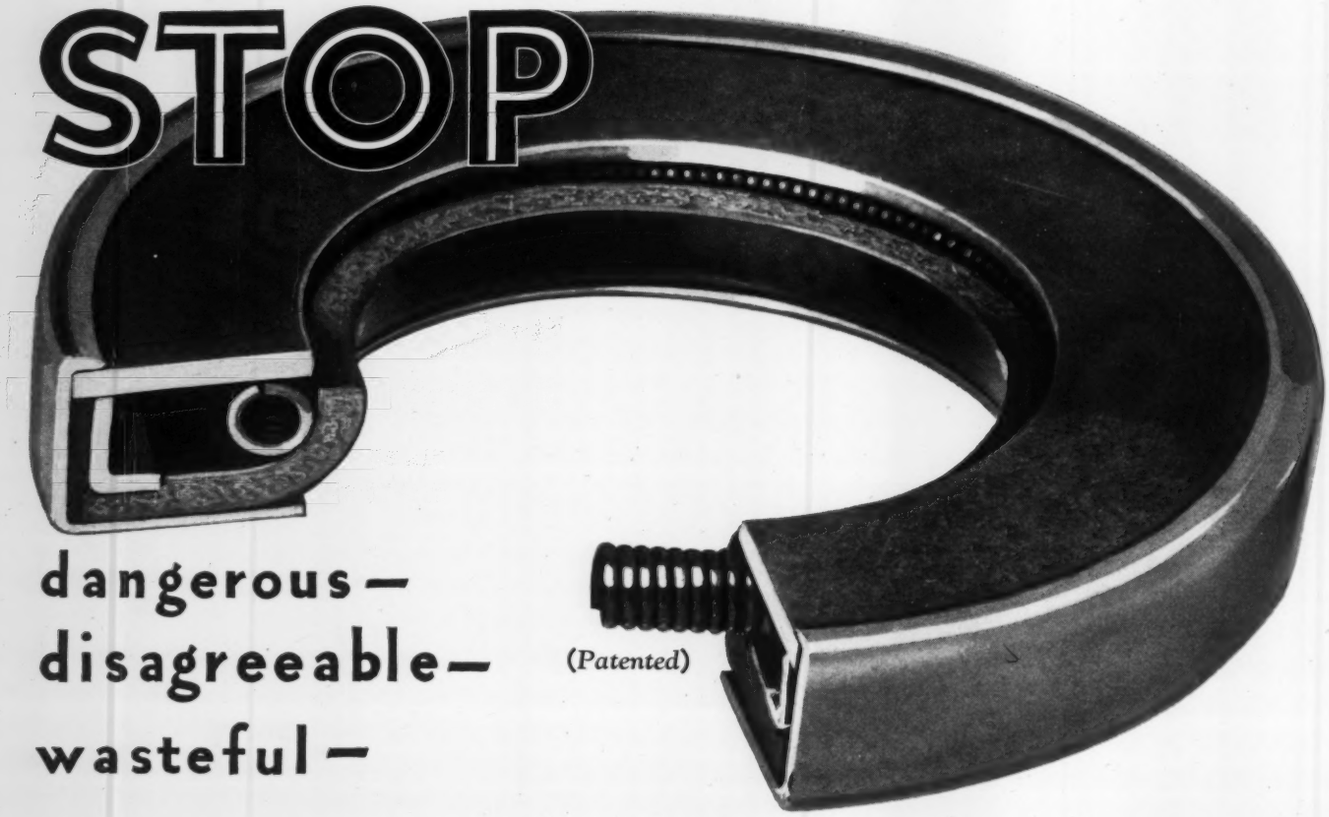

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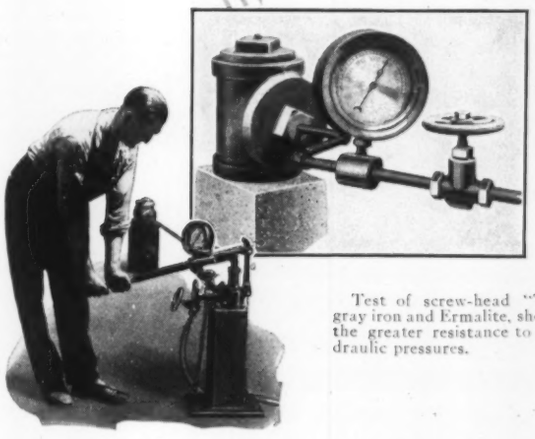

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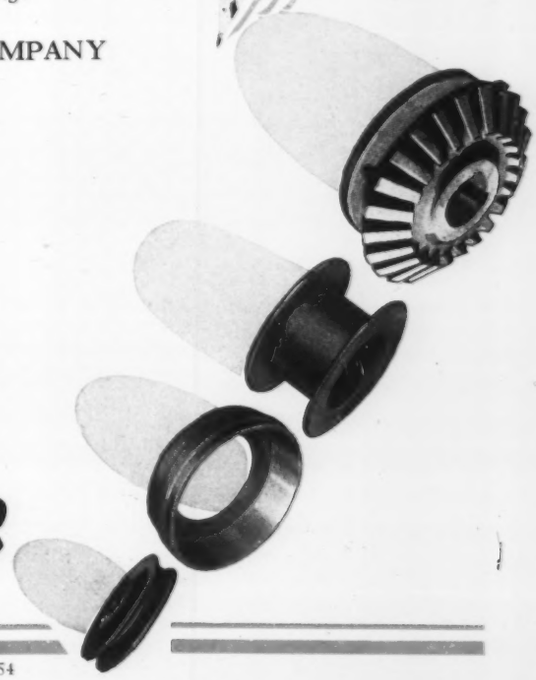

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CALENDAR OF MEETINGS AND EXPOSITIONS

Jan. 3-10, 1931—National Automobile Show. 1931 auto exposition occupying four exposition floors of Grand Central Palace, New York. The Chicago section of the show will be held in the Coliseum from Jan. 24-31.

Jan. 8, 1931—Society of Automotive Engineers. Annual dinner in New York. John A. C. Warner, 29 West Thirty-ninth street, New York, is secretary of the organization.

Jan. 10-16, 1931—American Road Builders' association. Twenty-eighth annual convention and road show to be held at St. Louis. In conjunction with the meeting an exposition of road building and maintenance equipment will be held. These exhibits will reveal a vivid picture of the progress being made in design in this field. Final report of a committee which has been studying highway equipment will be drafted and presented at the convention. Greater standardization of equipment and practices is expected to be a topic of interesting discussion. Solution of what is viewed by highway engineers to be some of the major problems in road building is sought by the committee of the American Road Builders' association, which is conducting research on grading equipment and methods. A final report covering the findings of this group will be presented for acceptance at the meeting. Committee reports will comprise the programs of various division meetings and will represent most progressive ideas. With St. Louis the hub of highway construction activity, it is noteworthy that this city will be host to the gathering.

Jan. 19-23—Society of Automotive Engineers. Annual meeting to be held in Detroit. John A. C. Warner, 29 West Thirty-ninth street, New York, is secretary of the society.

Jan. 23, 1931—National Association of Engine and Boat Mfgr's. Meeting in New York.

Jan. 26-29, 1931—American Society of Heating and Ventilating Engineers. Annual meeting at William Penn hotel, Pittsburgh. A. V. Hutchinson, 51 Madison avenue, New York, is secretary of the organization.

Jan. 26-30, 1931—American Institute of Electrical Engineers. Annual winter convention to be held in New York. F. L. Hutchinson, 33 West Thirty-ninth street, New York, is secretary of the organization.

Feb. 10-14, 1931—Midwestern Power Show. Fifth midwestern power engineering conference and exposition, generally known as the Chicago Power show, to be held at the Coliseum in Chicago. Further information may be obtained by addressing the Midwestern Engineering exposition, 308 West Washington street, Chicago. Concurrently the Fourth National Fuels meeting of the American Society of Mechanical Engineers will be held at Stevens hotel, Chicago. Wednesday and Thursday sessions will parallel sessions of the Power conference. R. R. Leonard is field secretary.

Feb. 16-20, 1931—Western Metal congress. Second National Western Metal congress and exposition to be held in Civic auditorium, San Francisco, under the auspices of the American Society for Steel Treating. W. H. Eisenman, 7016 Euclid avenue, Cleveland, is secretary.

Feb. 24-27, 1931—Southwest Road Show and School. Sixth annual event at Wichita, Kan.

April 12-16, 1931—American Society of Mechanical Engineers. Joint national meeting of the materials handling and management division to be held in Cleveland at the time of the industrial equipment exposition. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary of the society.

April 20-23, 1931—American Society of Mechanical Engineers. Semiannual meeting at Birmingham, Ala. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary of the society.

May 4-8, 1931 — American Foundrymen's association. 1931 annual convention and exhibition to be held at Stevens hotel, Chicago. C. E. Hoyt, 222 West Adams street, Chicago, is secretary of the organization.

May 7-9, 1931—American Gear Mfgrs' Association. Annual spring meeting to be held at Hotel Statler, Buffalo. T. W. Owen, 3608 Euclid avenue, Cleveland, is secre-

June 8-12, 1931—National Electric Light association. Fifty-fourth convention and exhibition at municipal auditorium, Atlantic City, N. J. Frank H. Gall, 420 Lexington avenue, New York, is secretary-treasurer of the organization.

June 22-26, 1931—American Society for Testing Materials. 1931 annual meeting to be held at Stevens hotel, Chicago. C. L. Warwick, 1315 Spruce street, Philadelphia, is the national secretary of the organization.

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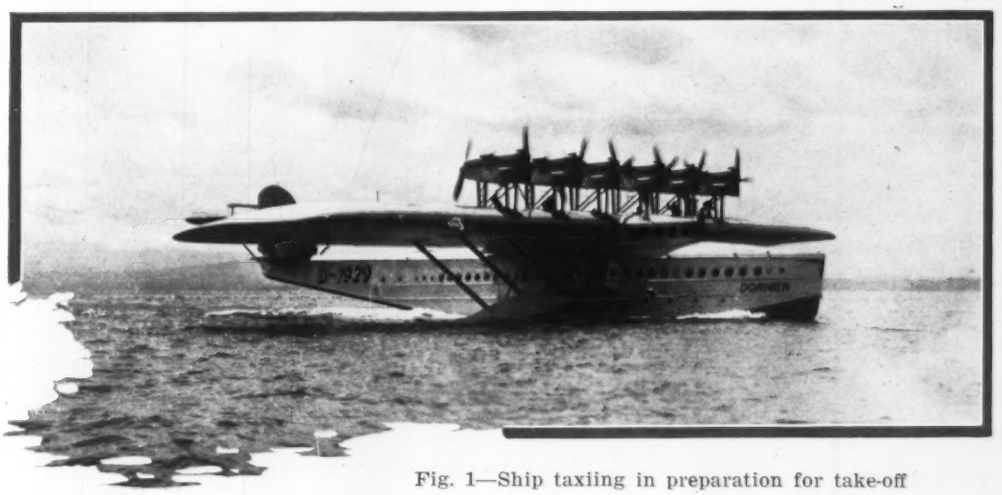


Fig. 1—Ship taxiing in preparation for take-off

Solving Weight-Strength Problems in Design of the DO-X

By John F. Hardecker
Chief Draftsman, United States Naval Aircraft Factory, Philadelphia

THE Dornier DO-X flying boat, the world's greatest airplane, is a matter of international interest particularly to the engineering fraternity. This tremendous flying boat challenges the imagination with its wing span of nearly 160 feet, a length of a little more than 131 feet and a height of 33 feet, with a power plant of 12 engines in tandem.

Equally startling is the fact that for the first time in actual practice the hull of the plane has been divided into three decks, one above the other, and that likewise for the first time the pilot has been relieved of the supervision of the power plant. Add to this the famous flight made by this plane with 169 people on board, and you have an array of unusual features that makes the placing of proper emphasis on its many innovations a matter of extreme difficulty.

Yet to the designer of machinery, the DO-X represents something more than an amazing aeronautical achievement to which to pay due design tribute. It, more than any other single plane—one is almost tempted to add more than all other planes combined—points the way to the fulfillment of a new design creed which has its counterpart in all machine design. In an age featured by a great movement to

LONG association with problems in the design of many types of airplanes has enabled Mr. Hardecker, author of the accompanying article, to appraise the design features of the DO-X and to emphasize those points which are especially significant. His description includes interesting details.

eliminate unnecessary and unneeded weight in all design, the airplane industry as a whole has pioneered the way for others. Many a designer, in full agreement with the value of the basic design precept of "maximum strength for minimum weight," has hesitated to carry his acceptance into practice because he reluctantly failed to see any similarity between the traditionally bulky machine of 25 or 50 tons with which he was dealing, and the comparatively light and flimsy flying machine of a mere ton or two so prevalent in general flying activity.

In the mind of many a general machine designer the airplane became a thing apart, a machine which of very necessity had to be of inherent light weight before it could function as a machine. Succeeding developments of planes even to the present day in our own country bear a marked resemblance to the original Wright machine. It was easy to discern that aeronautics had evolved a new technique of material selection and fabrication predicated upon the minimum weight-maximum strength precept. Each new plane conceived had for its inspiration all planes previously built.

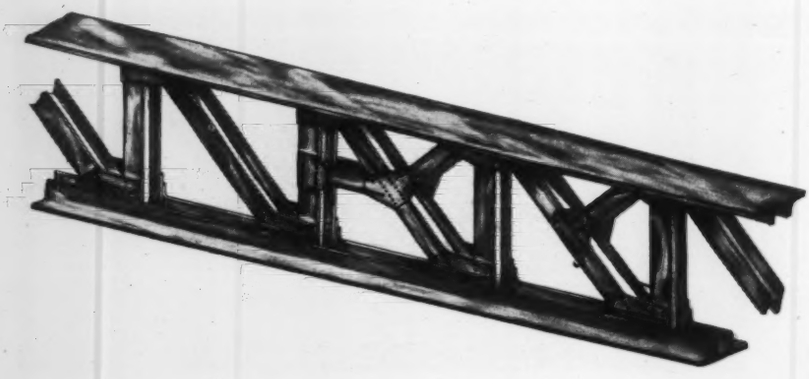
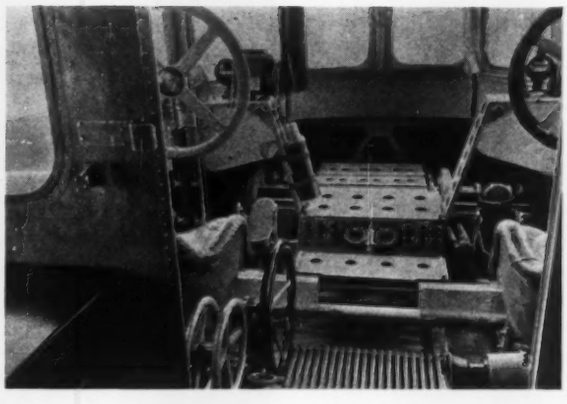


Fig. 2—(Left)—Construction details of spar. Fig. 3—(Below)—Pilot room. On the lower panel are two collective tachometers for six motors each, and the twelve warning lamps. Lower wheels are for the water rudder and the elevator and rudder adjustment



Designer Faced with Tremendous Task

Devoid of practical experience the designer still had to bridge the vast gap between the one to ten-ton machine and that of 25 to 50 tons. Aeronautical men insisted that the principles involved were the same, but how was the designer to gain his initial experience and the practical assurance that they were? Then came the DO-X. This huge flying machine which fully loaded exceeded 50 tons in weight was a distinct individual effort. It detracts not a single particle, now that the veil of secrecy and mystery has been removed, to bear witness to the fact that the DO-X is not a freak aeronautical invention, but is the logical and natural development of a series of flying boats designed by Dr. Claude Dornier. It has been engineered according to the best current aeronautical practice, all its unusual features having been determined and influenced by the basic demand for maximum strength and utility at minimum weight.

The DO-X has taught a lesson that reaches far beyond its amazing capabilities as a huge transport machine using the air as a medium of travel. In the popular imagination it is a "thing apart" in aeronautical development, but to the designer and engineer it has demonstrated that fundamentally sound engineering principles can be applied to design regardless of apparent differences in external and obvious appearances. Weight control has been as rigidly adhered to in the development of the DO-X as it has been in any single place open cockpit plane thus far built.

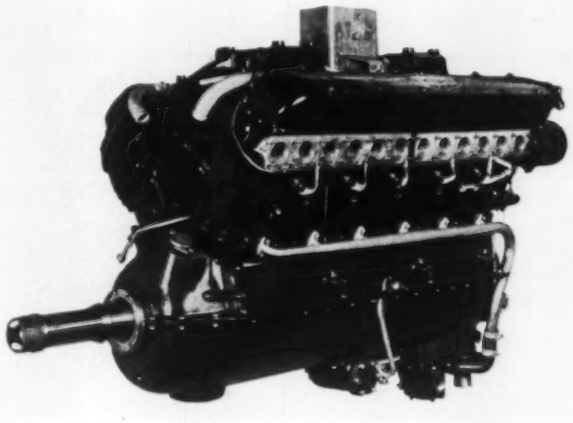
In the spring of 1928, in a paper before the Royal Aeronautical Society at London, England, Dr. Dornier gave certain information about the estimated weights of the DO-X. These weights are listed in the first column of Table 1. The second column contains the actual weights as of July 31, 1929. Weights for fuel and oil equipment and instruments, as given in the first column, were reduced to a common basis for comparison with other airplanes. In the third column are given corresponding weights proportioned from the actual weights of the second column. The total difference in weights on this basis is 4829 pounds or 8.8 per cent. If the additional weight of the engines and propellers, amounting to 1724 pounds is subtracted, a total weight increase of 3102

pounds, or 5.6 per cent remains for the airplane itself.

Weight Influenced Design Specifications

It is not proposed to hinder the interest inherent in a general description of the DO-X by constant reference to detail weight considerations. The reader is invited to bear in mind that perhaps the most important factor influencing any particular design decision made, has been this requirement of minimum weight. It must not be assumed that because any phase of the design is described as it now exists, that this necessarily was always so from the inception of the design. Many alternatives were "weighed" in each case, both figuratively and actually.

Early plans provided for seven engines with a total output of 4200 horsepower, but 12 engines with a total output of 5800 horsepower were decided upon later, and the powerplant that first was installed actually provided 6300 horsepower, because the performance of the engines had been increased. The decision in favor of 12 engines was based on the fact that units of 800 to 1000 horsepower, such as would have been necessary if only 7 were used, are not as reliable as engines of 500 to 600 horsepower. The original installation of 12 air cooled Siemens-Jupiter 525 horsepower engines has been replaced by a like number of water cooled Curtiss Conqueror 600 horsepower engines for the contemplated trans-Atlantic flight. The tandem



installation of the engines was the necessary result of their number.

The Curtiss Conqueror 600 horsepower engine is of the fluid cooled 60 degrees type, using two blocks of six cylinders each. Cylinders are of wet sleeve construction. Two dural carburetors are used, these being placed in the V. Ignition is by means of a high tension dual magneto embodying two separate and complete electrical circuits, each circuit supplying current to an engine driven distributor. The cylinders have a 5⅛-inch bore and a 6¼-inch stroke, making 1569 cubic inches displacement. There are two inlet and two exhaust valves per cylinder, all valves being interchangeable. Aluminum bronze valve seats are inserted in the cylinder head. Two camshafts are employed per cylinder head, one operating the inlet valves and the other the exhaust valves through T-shaped cam followers.

In the DO-X the engines are mounted above the wings in pairs, with a small auxiliary wing joining them. This small wing above the main wing has attracted great attention, and all sorts of speculation has been current about its aerodynamical advantages. Actually this auxiliary wing is a structural member, first and foremost, serving to steady the engine mountings laterally. It is built entirely of metal, and has been made quite heavy in order to reduce distortions and vibrations to the minimum. The engine nacelles are of framework design and have streamline cowling and large doors.

The boat hull is of fairly normal Dornier de-

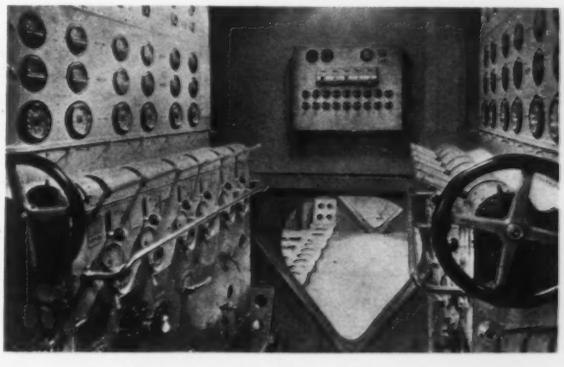


Fig. 5—Central engine control room. The handwheels are used as collective throttles, each for six motors; individual throttles are shown behind the wheels. Above the wheels are tachometers, thermometers for oil and water, oil level indicators, and oil and fuel pressure gages. Below are knobs for coupling throttles with collective shaft, ignition controls, ignition switch and short circuit switch.
Fig. 4—(Left)—Curtiss Conqueror 600 horsepower engine

sign as regards its external shape. Minor differences are the projection of the control cabin above the main deck, and the rounding of the stumps into the hull, affecting the drag of the boat adversely and favorably, respectively. The total length of the hull is 131 feet 4¾ inches; the breadth, measured over the stumps is 32 feet 9¾ inches; actual beam is 10 feet 8 inches and the maximum height is 21 feet. The volume of the hull, including the stumps, is 14,126 cubic feet. When we compare this with some of the contemporary European flying boats (Superwal 3531 cubic feet and Romar 2649 cubic feet we get a true picture of the tremen-

dous increase in size of flying boats represented by the DO-X.

On the upper deck are the captain's bridge, the pilot's room, central control room, radio room and the room for auxiliary machinery. The middle deck is exclusively for passengers. It is a little over 77 feet long, 6½ feet high and 11½ feet wide at the widest point. On the bottom deck are the fuel and oil, stores, freight and luggage.

Long Keelson Increases Rigidity of Ship

The boat has a center keelson 76½ feet long, extending from the bow to the end of the stern step, 7 feet high at the highest point. This adds greatly to the rigidity of the boat. To the right and left of the keelson, at distances of 2 feet 11½ inches and 5 feet 3¼ inches respectively, are fitted bilge keelsons. In combination with the transverse frames, which are 58 in number and spaced 2 feet 3⅝ inches, this results in an extremely effective framework. The exceptionally strong sheet metal plates on the bottom of the boat, which are exposed directly to the sea, are divided by the intersecting transverse frames and longitudinal members into sections of about 6¾ square feet. Pressed structural shapes were used as far as possible, in consideration of the allowable weight, in making the transverse frames.

The wing is a semi-cantilever type, the full cantilever wing design having been abandoned to save weight. A plan of the wing is rectangular, with slightly rounded tips. The middle span is located at about the point of maximum profile height, the chord or width of the wing being 31 feet 2 inches. Front and rear spars are wide apart, each 9 feet 2¼ inches from the middle spar. Cross members between the spars are spaced up to 11 feet 9¾ inches apart. The whole frame work of the wing, with the exception of certain steel fittings, is made of duralumin. In regard to this, Dr. Dornier states "This might lead to the conclusion that I have changed my views regarding the advisability of utilizing steel in airplane construction; but I have not changed my views in this respect. It was merely impossible to obtain soon enough the steel angle and plates of the dimensions necessary. I regard the use of steel as having a great future—especially in very large machines the structural parts of which have sections in which steel can be used to the best advantage."

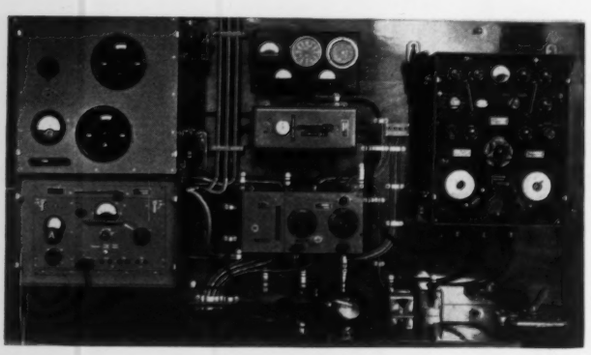


Fig. 6—Radio installation. Main sender, 600 to 2100 meters; short wave sender, 30 to 60 meters; receiver 20 to 3000 meters

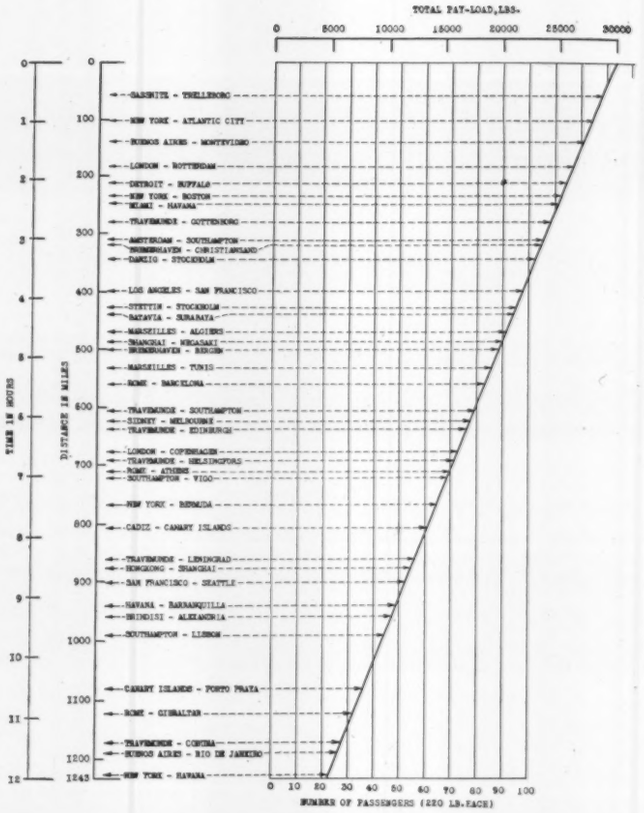


Fig. 7—Chart showing a selection of routes, with flying time, pay loads and number of passengers

Supplementary Plates Are Used

Girders of the spars are built up of dural plates and shapes, similar to the shapes used in bridge building. Supplementary plates are utilized at various points according to the stress. The spars afford a good example of the common experience that less work is required per unit of weight to fabricate structural members of greater dimensions, because the amount of work depends mainly upon the number of joints and rivets. The DO-X has an average of 2.5, the Dornier Superwal 3.3 and the Dornier Wal 5.2 joints per meter (39.37-inch). Similarly, the number of rivets per kilogram (2.205 pounds) of finished spars is 9.8 for the DO-X, 33 for the Superwal, and 44 for the Wal.

The tail surfaces are of fairly normal design, and are all provided with separate surfaces acting as balances. The surfaces are actuated by rods which are supported by rocking levers, the whole of the linkage being carried by ball bearings, so that the control is remarkably light. Trimming of elevators and rudder is achieved

by a setting of the separate balance surfaces, the angle of which in relation to the main surface which they balance being adjustable from the cockpit. This requires no exertion of force and can be done from the pilot's seat by the two small handwheels at the side. The steering wheel control is normal.

Design of engine controls on a multi-engined flying boat like the DO-X present somewhat of a problem. Obviously, the pilot cannot attend to all the engines, their control, etc. Yet it is essential that the pilot should have full control of all available power. With the arrangement selected, there is a main engine control room, in charge of the chief engineer, and in this are concentrated the individual engine controls, engine instruments, etc. To avoid any possibility of confusion, all the controls and instruments belonging to the port engines are collected on the port side of the engine control room, and all those for the starboard engines on the starboard side. From this engine control room, two sets of engine controls are taken to the pilot's control cabin. Thus the pilot has but two engine controls, one of which operates the six port engines, the other the six starboard.

TABLE I

Comparison of Calculated and Actual Weights

	Predicted Weight Lb.	Actual Weight Lb.	Actual Wt. Corrected for Comparison Lb.	Difference in Weight Lb.	Per Cent
Wings and Struts	16,481.4	16,665.6	16,665.6	+184.2	+ 1.1
Tail Surfaces	1,606.5	1,936.1	1,936.1	+329.6	+20.6
Controls	711.0	801.4	801.4	+90.4	+12.7
Hull	15,951.1	18,329.2	18,329.2	+2,378.1	+14.9
Engine Nascelles and Supports	2,364.9	2,529.1	2,529.1	+164.2	+ 6.9
Paint	771.6	771.6	771.6		
Engines	10,408.0	11,291.2	11,291.2	+883.2	+ 8.5
Exhaust Manifolds	86.0	86.0	86.0		
Propellers and Hubs	1,587.3	2,429.2	2,429.2	+841.9	+53.0
Engine Controls	771.6	500.2	500.2	—271.4	—35.3
Fuel Tanks	2,026.0	2,725.8	2,209.9	+183.9	+ 9.1
Oil Tanks	605.1	792.8	662.5	+57.3	+ 9.5
Oil and Fuel Piping	264.6	264.6	264.6		
Powerplant Instruments	286.6	613.3	241.4	—45.2	—15.8
Flight Instruments	15.2	30.6	15.2		
Navigation Instruments	3.3	79.4	3.5		
General Equipment	67.2	176.4	67.2		
Auxiliary Operating Equipment	429.5	920.4	414.5	—15.0	—0.35
Marine Operating Equipment	551.2	596.8	596.8	+45.6	+ 8.3
Total	54,987.9	61,539.8	59,815.1	4,827.2	

In the description of the various component divisions of the DO-X, brief though it has been, we have of necessity omitted detail reference to weight control. As a final indication of the extreme significance of this matter, attention is called to the chart shown in Fig. 7, which is presented in the form of a graph. This chart gives a selection of routes suitable for the DO-X, beginning with short distances and extending up to 1243 miles. The graph shows the flying time and pay loads for the respective routes and further the number of passengers to be carried in each case, each passenger being reckoned at 220 pounds. The maximum number of passengers that can be comfortably accommodated is placed at 100. If the useful load permissible amounts to more than 22,000 pounds, the difference can be made up with mail or freight. The diagram is based on the assumption that the take-off weight should amount to approximately 100,000 pounds without wind reserve. The take-off weight therefore would be increased in practice by the weight of the reserve gasoline and oil to be carried.

The chart shows that a useful load of 26,500 pounds can be carried between Buenos Aires and Montevideo and that this load corresponds to 100 passengers and 4500 pounds of mail or freight. Between Hamburg and Southampton or Marseilles and Algiers, a useful load of 19,800 pounds or 90 passengers can be carried. What the chart does not show, but which readily is apparent, is that a mere addition of 200 pounds to any of the permanent parts of the plane, whether it be structure, engine, mechanism or control, irrevocably eliminates one passenger from the pay load on every flight, unless a corresponding saving in weight is introduced in some other part of the plane to cancel the effect. This shows conclusively how intimately the matter of weight control is linked up with the economic utility of the plane.

FIRE burned the left wing of the DO-X to the bare metal frame work as the ship lay in the Tagus River at Lisbon, Portugal, on November 29. The blaze, according to despatches, originated in the auxiliary engine room, and spread to the gasoline tank in the wing, causing an explosion. Repairs required two weeks. Engineers over the world are hopeful that a transatlantic flight will be completed successfully.—The Editors.

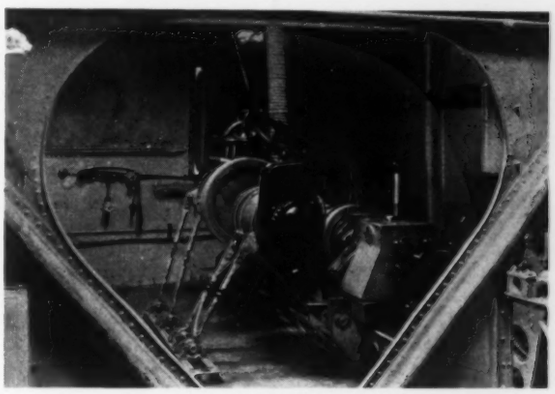


Fig. 8—Auxiliary engines showing aggregate of twelve horsepower gasoline motor, (water radiator), compressor, light and power generator and heating generator for kitchen

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

OF OUTSTANDING importance in the field of metal cutting machinery and symbolical also of the increasing use of electrical control mechanisms on standard machines, is the new form turning lathe developed by Monarch Machine Tool Co., Sidney O. The machine, illustrated in Fig. 1, is a combination of a precision engine lathe and a Keller automatic electric control unit consisting of a standard tracer, two magnet boxes and a control cabinet.

With the new machine it is possible to turn or bore intricate shapes with a minimum of attention on the part of the operator. Some of the parts which can be produced economically are: die casting dies, molds for glass bottles, can forming dies, chucks for sheet metal spinning, punches and dies for hollow ware, etc.

The tracer mechanism of the control unit is mounted on a bracket of the lathe in fixed relation to the cutting tool. Front and rear magnet boxes are geared to the feed rod and lead screw respectively. A thin metal templet of the desired form is mounted on a bracket at the rear of the lathe, parallel to the longitudinal or cross feed, depending upon the position of the work in the machine.

After the directional switch is pressed, the machine is automatic. The tracer moves to the templet automatically, maintaining a light mechanical contact. Variations in the movement of the cutting tool conform to the contour of the templet which the tracer is following, and remarkably close accuracy is obtainable. The tracer operates relays by a 14-volt direct current not exceeding 5 amperes, which in turn actuate magnetic clutches by the regular 110-volt shop current.

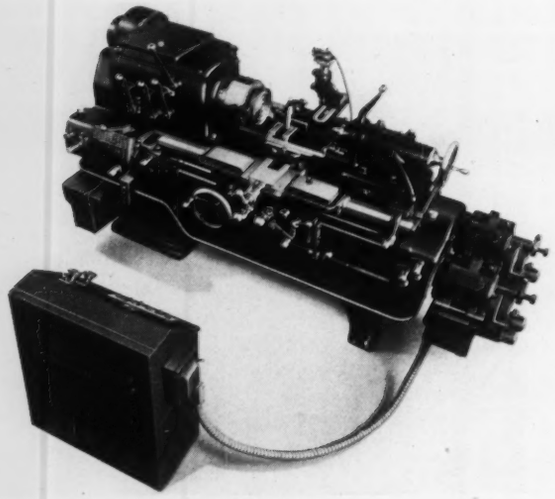


Fig. 1—Combination of lathe and electrical control unit for form turning

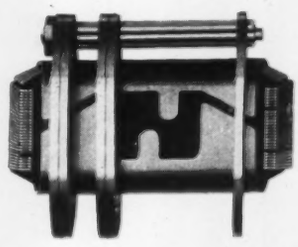


Fig. 2—Single link of the chain used in new variable speed transmission. The ends of the laminations conform to the slots or teeth in the driving and driven disks

Unique Chain Provides Variable Speed

IN THE June issue of MACHINE DESIGN a description and illustration were given covering a template built up from laminated plates. This gage was intended for obtaining simple or even intricate contours, the ends of the plates conforming to the shape of the part the gage is pressed against.

It is interesting to note that a similar idea is employed in a variable speed transmission unit which has been under development for some time and was announced recently by the Link-Belt Co., Chicago. The unit is similar in some respects to other variable transmissions which have been on the market for some time but the new gear, called the P. I. V., embodies a distinctly original feature in that it employs a chain drive for the transmission of power. Radial teeth are cut in the faces of adjustable driving disks and the self-adjustable teeth projecting beyond the sides of the chain are arranged to engage the radial teeth of the disks. This may be seen in Fig. 3, showing the chain engaging the minimum diameter of the wheel or pair of disks in

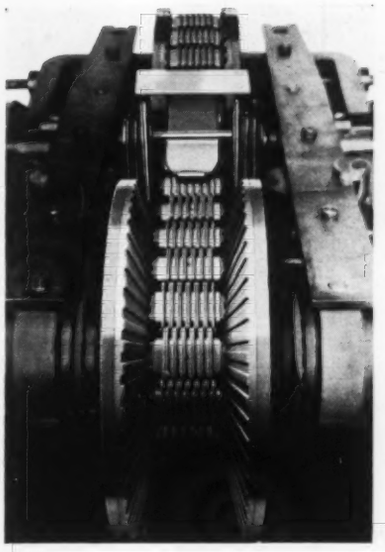


Fig. 3—Illustrating the tooth formation of the chain on the minimum diameter of a wheel. Positive drive is assured, as the slats move back and forth into the teeth to mesh correctly as the chain comes into contact with the wheels

the foreground. On changing the speed of the driven shaft, the chain rises in one set of disks and descends in the other, the effective diameters of the wheels being changed by pressing one pair of disks closer together while the two on the other shaft are being drawn apart.

The chain is made up of a series of steel leaves or links with joints consisting of hardened steel pins turning in segmental bushings. As will be seen from the link shown in Fig. 2, there are no teeth on the inner surface of the chain. Instead, what may be called teeth are made up of packs of hardened steel laminations or slats which extend through slots in the links at right angles to them, and project about ⅛-inch at each side of the chain. Individual containers which hold the packs of slats are secured in openings in the links. Within each such container the slats are free to slide from side to side individually with relation to each other and adjust themselves to engagement with the radial teeth of the disks, over substantially the full range of diameters. The 30 degree angle of the slat ends is the same as that of the conical faces of the wheels.

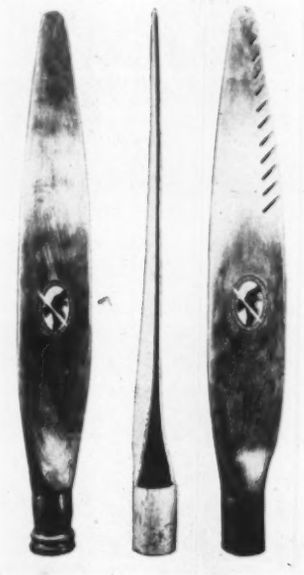


Fig. 4—Three airplane propeller blades of the new hollow steel type. At the left is shown a finished blade; center, a blade cut away to show the hollow construction and wall thickness; and at the right, the special design with slots to provide escape for exhaust gases

Propeller Blades of Hollow Steel

ARE the old-time wood and more recent aluminum propeller blades to be replaced by blades constructed from hollow steel? Two companies in Pittsburgh are developing propellers of this type, Pittsburgh Screw & Bolt Corp. and the Hamilton Standard Co. Various blades are shown in Fig. 4.

The blades are fabricated in different ways,

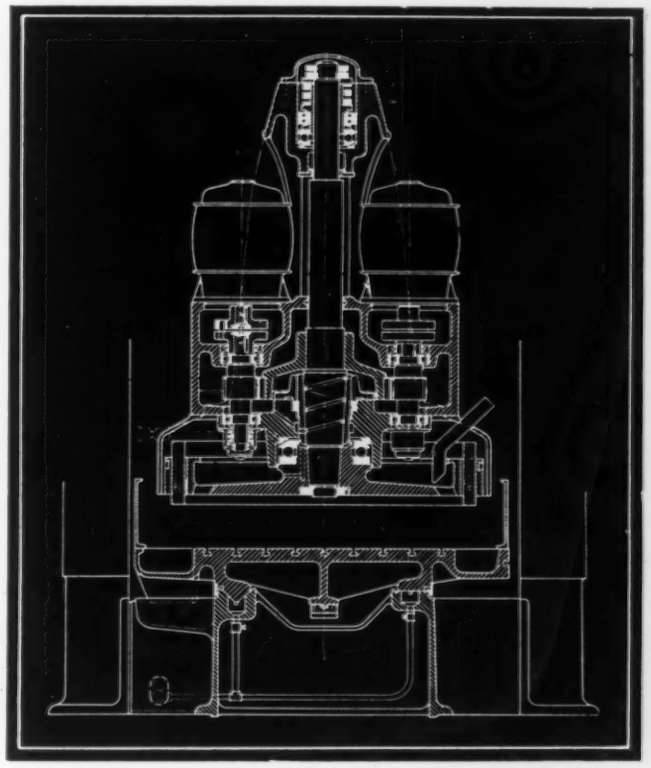


Fig. 5—Two motors are employed for driving the grinding wheel on new surface grinder

one company employing a tube and the other welding together two steel plates shaped to the proper contour and angles in special dies. Welding of the plates is a feature of the blade's construction, the process involving a joint that prevents the seams from becoming either the leading or trailing edge. This is accomplished by cupping one plate sufficiently to permit the other to lie within it, thereby eliminating tension in the weld.

One type of blade provides for the escape of motor exhaust gases by leading the gases into a collector ring, through the propeller, and thence through slots cut in the trailing edge. Tests made by the bureau of aeronautics disclosed a marked increase in engine efficiency

through the use of this exhaust system. The device also was pronounced the most effective muffler tested to date. In addition, the use of steel propellers is expected to eliminate most of the pitting and erosion now encountered in seaplane service in using aluminum alloy blades.

Grinding Wheel Has Two-Motor Drive

A UNIQUE method of driving the wheel of a massive surface grinder is incorporated in a machine developed recently by Naxos-Union company at Frankfurt-on-Main. The wheel is of the segmental cup type, 55 inches in diameter, and operates at 4900 surface feet per minute.

Due to the large diameter of the wheel a comparatively slow shaft speed is essential and consequently a single built-in motor with the armature on the wheel spindle would have necessitated an exceedingly heavy and expensive motor. Two smaller standard motors therefore are employed and these drive the wheel through geared reductions as shown in Fig. 5.

Riderless Car Remote Controlled

REMOTE control is employed in an interesting way to operate a riderless rail car system at the Trinity Portland cement plant at Dallas, Texas. Each car is equipped with two 50 horsepower General Electric squirrel-cage motors, the power being collected from an extra rail. Two operators are located where they can view the loading and unloading and govern movement of the cars, two of which are shown in Fig. 6.

The track is divided into sections, one insulated from the other. By energizing all sections, a car runs from one end of the track to the other. If one section only is electrified the car automatically is stopped by brakes as it runs onto the "dead" section. Another unusual feature is the conservation of power, which is effected when cars go down grade by gravity. Electricity is produced by the motors which act as generators, and fed back into the power system to assist in operating other cars.

Fig. 6—Section of track showing two riderless cars and extra rail system

Unloaders Have Huge Capacity

PROGRESS in the design of massive machinery is exemplified by the ore unloaders recently erected on the C. & O. railroad docks at Toledo, O. Electrically driven, the first of their kind to be operated by alternating current, these huge units pick up 17 tons of ore at a bite and repeat the operation every 50 seconds. It is noteworthy also that a crew of only three is required for each unloader, an operator, weigher, and attendant.

Some conception of the size of these machines can be gained from the fact that they span four tracks, moving on main tracks 72½ feet apart. Travel is about 50 to 75 feet a minute. In operation, the dipper picks up the ore from the hold of a boat and places it into a 50-ton disk hopper, which discharges into a traveling scale lorry. This car in turn dumps the ore into cars beneath the span.

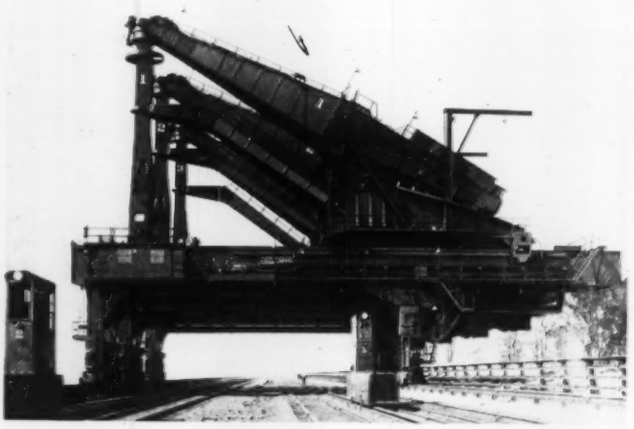


Fig. 7—General view of the unloaders showing four tracks passing beneath

A small cab is provided for the operator directly above the dipper. In the control room immediately above the three wheels of the upper structure which is shown in Fig. 7, are located both alternating and direct current control panel boards. Eight Westinghouse motors totaling 1060 horsepower operate each unloader.

The present installation consists of three stiff-legged hoists, each with a capacity of 1200 tons an hour. Main motions, beam hoist, and trolley travel are operated by direct current, with variable voltage control; all other operations are handled by alternating current, with full magnetic controllers. The vast amount of ore and coal handled by the lake ports has made it necessary and profitable to trans-ship by efficient electrically operated machinery.

Photoelasticity— and Its Application in Design

By R. V. Baud

BECAUSE it illustrates the scope of the photoelastic method of stress analysis this article, the second of a series, will be found particularly enlightening. The author is associated with the Westinghouse research laboratories, mechanics division, and has had extensive experience in this field.

PHOTOELASTIC tests have been made on a great many mechanical shapes and have proved of considerable value in design work. The present article covers work done under the following classifications which may be of particular interest to designers:

1. Gears.
2. Bolts.
3. Suspension insulators.
4. Glassware.
5. Locomotive side frames.

It is beyond the scope of this series of articles to give in detail the numerical results obtained, the empirical equations derived and the recommendations advanced on the basis of these studies. Instead, an attempt is made to sketch the principal results obtained in as concise a manner as is possible, with the object of enabling the machine design executive to form his own opinion of the usefulness of photoelastic stress analysis.

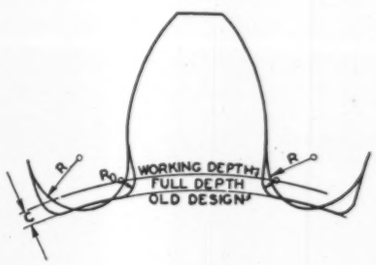
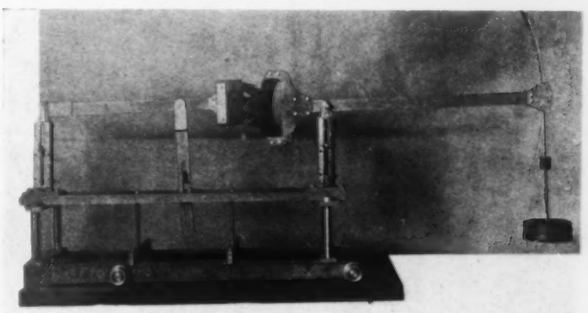


Fig. 1—(Left) —Old and new gear tooth root design. Fig. 2—(Right) —Loading arrangement for large gears

In developing spur gearing the problem consists ultimately of determining the life that a gear will give under given service conditions. Toward this end it is necessary to know how the load is divided among the teeth and the magnitude of the stresses produced due to external loading of the teeth and due to shrink fits.

Gear designers use extensively the Lewis formula for computing the safe load. This formula is substantially the same as the standard beam formula, and consequently does not include the concentration that is produced at the root of the tooth, nor does it consider load division. Both phenomena have been studied photoelastically with the result that a modified gear formula and a modified design of the root was suggested,[1] Fig. 1, and increased contact ratios were recommended.[2] Studies regarding the stresses produced by shrink fit also were carried out. Recently, some improved bending tests were made with sectors representing large locomotive driving gears with the teeth in proper contact, Fig. 2. Rules that permit the construction of the stress cycle curves for teeth similar to those tested were derived from the results.

Contact stresses determine the wear of gear teeth and deserve the same careful attention as bending stresses. Their importance is realized but they are not considered always in the design due to lack of proper information on this subject. This information can be obtained from photoelastic tests, insofar as the magnitude of the stresses is concerned. Some work already has been done along this line. It has been pointed out, for instance, that the maximum shear



[1] "The Strength of Gear Teeth" by Timoshenko and Baud, *Mechanical Engineering*, Vol 48, No. 11, Nov. 1926, p. 1105.

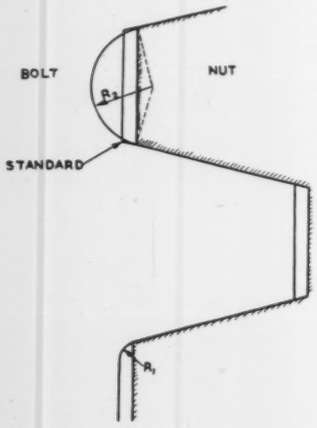
[2] "Load and Stress Cycles in Gear Teeth" by Baud and Peterson, *Mechanical Engineering*, Vol. 51, No. 9, Sept., 1929, p. 653.

stress does not occur at the surface in contact, but somewhat below this surface. It was found furthermore that unless the gears are designed especially with a contact ratio larger than 2, the maximum shear stresses are extremely large near the pitch point, as one tooth alone carries the total load for this particular angular position of the gear.

Change in Tooth Design Suggested

A change in design of the root as recommended by the writer in 1926 on the basis of a first series of photoelastic tests. The change, as Fig. 1 shows, consists in connecting the flanks of adjacent teeth by one large semicircular fillet of the radius R. This has been adopted, for instance, in large locomotive gears for the Pacific railroad, Fig. 2. Tests made in the National Physical Laboratory in England have shown a remarkable increase of fatigue strength by this change.

The problem of bolts presented itself in connection with the design of plate rotors, Fig. 5. By "plate rotor" is meant a rotor that consists of a stack of plates between two end-forgings, the whole unit held together tightly by means of



four to six bolts. In most of the present four pole rotors the average computed tensile stress allowed is as high as 40,000 pounds per square inch. It therefore is desirable that local stress increases be kept as small as possible, inasmuch as there is a variation in the bolt load due to rotation and deflection of the rotor.

In order to enable the merits of different types of threads to be judged from this point of view, photoelastic tests were made with models representing Whitworth, buttress and acme threads. It was recommended from these tests that a modified acme thread should be employed with a fillet at the root having as large a radius R_1 as the clearance between nut and bolt allows Fig. 3.

In cases of large variations in the load, or brittle materials, or both, it is recommended to connect the flanks of two adjacent acme teeth by a semicircular fillet of the radius R_2 Fig. 3. For such loads and materials it is necessary to compute the maximum stress in the fillet of the first thread. This can be done, at least for the types of threads tested photoelastically, on basis of the results that were obtained.

Further photoelastic tests were made with a model shown in Fig. 4 to study the distribution of the load over the threads. It was found with

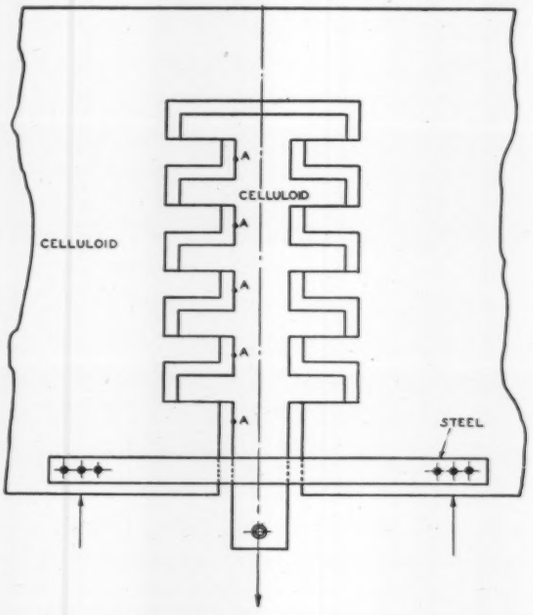
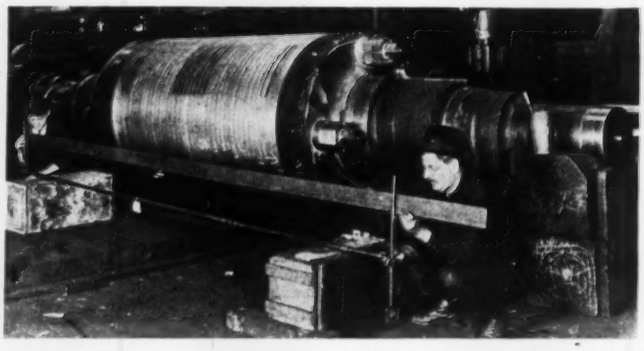


Fig. 3—(Left)—Sketch showing the standard acme thread and the modified form recommended. Fig. 4—(Above)—Load-division tests of screw threads. Fig. 5—(Below)—Type of plate rotor the design of which involved problems in connection with the bolt fastenings.



this model that the first two threads take five-eighths of the total load. The last thread of the model carried somewhat less than one-eighth of the total load. From this and other studies it was concluded that the first six threads carry practically the entire load.[3] This conclusion permitted a recommendation to decrease the height of the nut from 1.4 the diameter d of the bolt to

[3] "The Mechanics of Plate Rotors for Turbo Generators" by J. P. DenHartog, *Transactions*. A.S.M.E., division of Applied Mechanics, Vol. 51, No. 10, 1929.

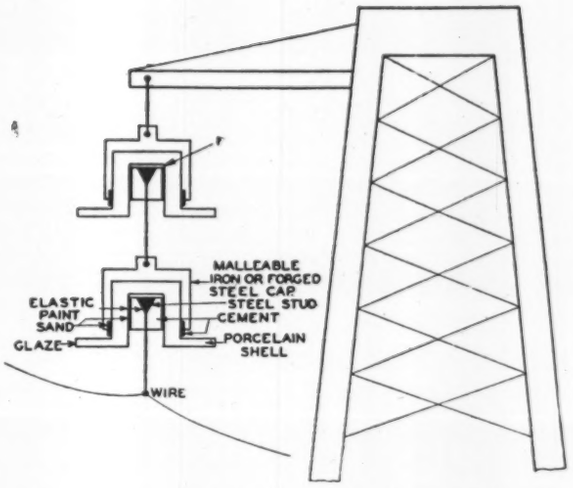


Fig. 6—Suspension insulators as tested

1.o*d*. It can be decreased further to .5*d* or .6*d* and still fail through the bolts. For heights less than about .5*d* the threads shear off.

Suspension insulators are used to suspend the wires of transmission lines. They consist of a steel cap, porcelain shell and a steel stud, Fig. 6. The stud is cemented in the pin hole of the shell by means of cement.

Photoelastic tests were made to explain certain failures that were obtained through the fillet *F* in the pinhole and to suggest changes in design to eliminate these failures and result generally in increased mechanical strength. Valuable results were obtained of which the most outstanding was the stress concentration in the fillet *F*. The change in design that was recommended provides for larger radii, particularly of the fillet *F*, the fillets on the stud, and spherical form of the shell. Change of the fillet radii resulted in an increase in the ultimate strength of 15 per cent.

The polarized light instrument also is frequently used to obtain information regarding the presence of residual stresses in objects made of transparent materials, particularly of glass.

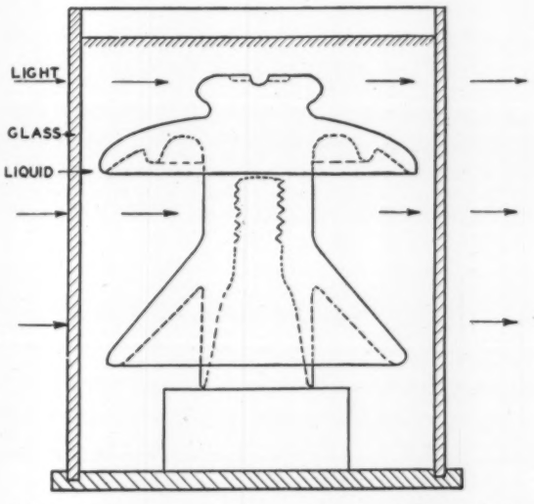


Fig. 7—Arrangement employed to test for initial stresses in insulator

If the test piece has the shape of a "two-dimensional" model, i.e., if it is a plane parallel plate, the examination is comparatively simple. If on the other hand the test piece does not possess two main surfaces parallel to each other, the light is incident upon the body or emerges from the body at an angle, and either reflection with subsequent scattering of light or single refraction may occur, which later may result in misleading color effects. Experiments therefore were made with the body immersed in a glass container filled with a colorless liquid of the same index of refraction that the glassware had, Fig. 7. In this manner the three-dimensional problem is reduced to a two-dimensional one, at least in some respects insofar as the surface of the body to be examined is concerned.

In one particular instance the glass had an index of refraction of 1.52. The solution used consisted of carbon tetrachloride and carbon bisulphide, so mixed together that the same index 1.52 was obtained. The interference colors are, in this case, an indication whether or not residual stresses are present.

The determination of the magnitude of the residual stresses offers certain difficulties as their direction is unknown, and the physics of polarized light that is not incident perpendicularly to the plane of the stress is not known sufficiently as yet. The experiment described in the foregoing therefore is at present of a qualitative nature only, but even so it is valuable and has been used in detecting residual stresses in power tubes, floodlight lenses, glass insulators, etc.

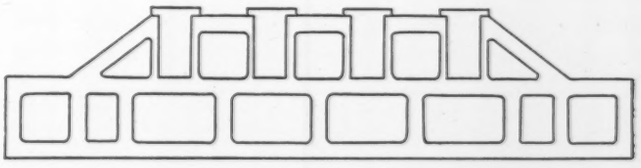


Fig. 8—Sketch of locomotive side frame

Locomotive Side Frames

In changing traction from steam to electricity the designer of electric locomotives is confronted with the problem of designing locomotives of the same capacity as steam locomotives, or even larger, but without the vast experience that has been gathered through a century of steam traction and which is available to the designer of steam locomotives. It is, therefore, natural that the designer of electric locomotives takes recourse to new methods of research to solve his problems.

Important elements of locomotives that have been studied photoelastically are the side frames. Their importance lies in their heavy

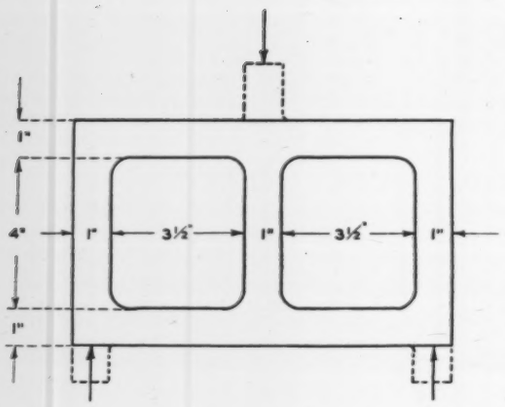


Fig. 9—Model of frame tested

duty to take up the vertical forces (weights and reactions), longitudinal forces (traction) and lateral impact forces due to changes in direction.

A locomotive side frame consists primarily of a large number of panels, such as sketched in Fig. 8. In planning systematic photoelastic research of the stresses produced in such structures it was thought advisable to begin with simple problems considering frames that consist of two panels only, loaded as shown in Fig. 9.* The object of the tests was two-fold: (1) to compare the experimental with analytical data and (2) to study the concentration due to various size fillets.

Some results obtained are given in Figs. 10 and 11 in form of curves. A stress acting tangentially to the boundary is represented by a vector perpendicular to the boundary. The dotted lines represent the computed stresses; the full lines give the magnitude of stresses that have been obtained photoelastically. It was seen from the test results shown and from others on frames having fillets up to one inch radius, that with exception of the stresses in fillets of small radii the experiments check the analytical work closely.

These and similar results are welcome to the designer as he then can tackle the problem of more than two panels similarly loaded and other combinations of panels with more confidence.

The concluding section of this series will appear in a forthcoming issue, dealing with stress analysis in rails, welds, fastenings, turborator elements and commutators.

*It was assumed that the stresses are substantially the same for tensile and compressive forces, only opposite in sign. To simplify the experiment, extensions were provided and tensile forces applied.

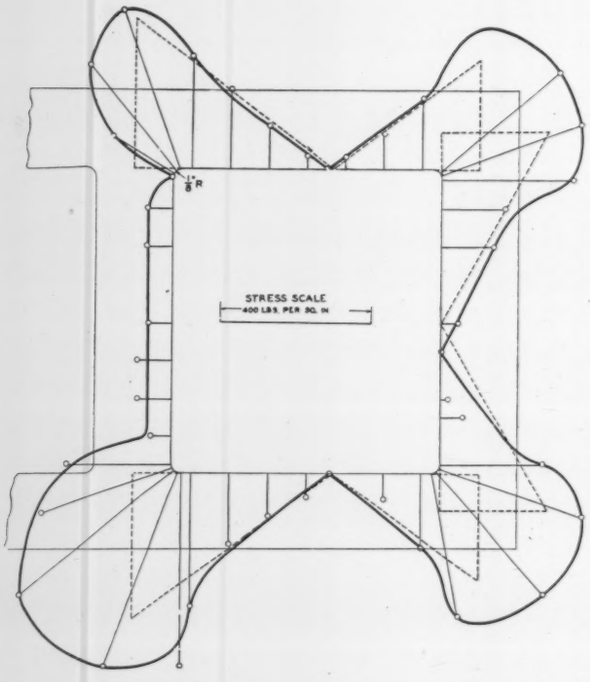


Fig. 10—Frame test results showing in full and dotted lines the actual and computed stresses respectively. Radius of fillets, one-eighth inch

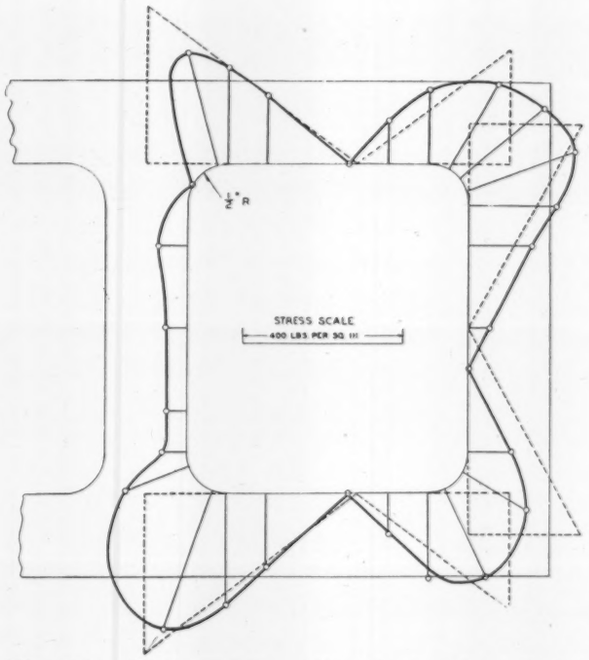


Fig. 11—Test results with fillets of one-half inch radius

GREATER accuracy in measurement of electricity now is nearing its final stages of development after years of research, according to Roger W. Curtis, division of electricity bureau of standards. Although the present inaccuracy is believed to be only fractional, yet a slight improvement in this respect would be of great importance in the aggregate cost of power. The purpose of the study undertaken is to attempt to determine the absolute value of the ampere and to reduce the percentage of error in the international ampere.

Reducing Calculations in Designing Crankshaft Members

By H. F. Shepherd

WHY treat individually the calculations for design of component parts of similar type machines or engines, particularly where constants can be established? Mr. Shepherd stresses the advantages of a standardized method of computation, basing his theory on the design of engine crankshafts.

THE laborious process of calculation usually followed in torsional vibration problems is costly if each case is treated as individual.

It is good business and certainly not bad engineering to design in such a way that assumptions are simplified for after all calculation is only as accurate as our knowledge of conditions.

Good management demands the reduction of the method of calculation to the simplest possible form so that it may be generally useful to all men in the department.

These principles most easily are applied to repetition jobs in which only the size of the machine is changed, its construction remaining the same. It then is possible to reduce labor in designing a series of units by learning the laws governing the proportions of their members. Often these reduce to the simplicity of arithmetic.

Reciprocating engine crankshaft calculations present some interesting mathematical properties when thus analyzed. For any series of engines assume that:

1. The crankshaft and pin diameters bear a simple and constant ratio to the cylinder diameter. For example, the crankshaft may be 6/10 or 5/8 or 7/10 the cylinder diameter.
2. The cylinder centers or main bearing centers also bear a simple and constant ratio to the cylinder diameter. As an instance, the main bearing centers may be separated 1.5 or 2 times the cylinder bore.
3. The crank arm sections are as in 1 and 2.
4. The stroke bore ratio is constant for all sizes.
5. All unit bearing pressures are alike for the same location.
6. All engines have the same number of cylinders.

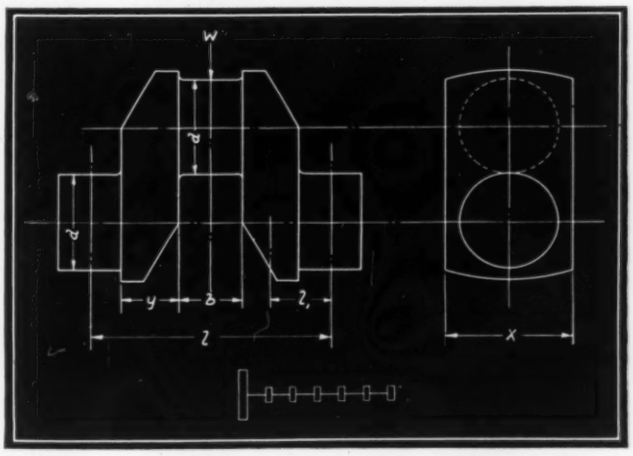


Fig. 1—Section of crankshaft in which shaft and pin diameters are equal

It remains now to demonstrate that these are rational and not "rule o' thumb" proportions.

Basic formulas in the following may be found in any book on machine design or in any engineers handbook. They are so long established that they need no exposition. The symbols, so far as possible, are those commonly used.

Crankshaft as a Beam

The first and simplest assumption in designing a crankshaft is that each section is a beam with the piston pressure load imposed at its center and finding support at the middle of each crankshaft bearing, or "main bearing."

The bending moment M_b of a beam of this class is $\frac{1}{4}Wl$ in which l is the distance between supports and W is the impressed load. Also, $M_b = S \times I/c$, in which S is the maximum fiber stress and I/c the section modulus.

I/c for a round section such as the crank pin equals $\pi/32d^3$ or $.1d^3$ approximately, d being the crank pin diameter. Thus

$$\frac{1}{4}Wl = .1d^3S \quad \text{or} \quad S = \frac{\frac{1}{4}Wl}{.1d^3}$$

Assuming that a series of crankshafts is to be designed in which d/D and l/D are constant,

D being the cylinder diameter,

$$W = \frac{D^2\pi}{4} \times 600$$

or the area of the piston multiplied by the maximum cylinder pressure.

$$l = K_l D \text{ and } d = K_d D$$

in which K_l and K_d are constants chosen by the designer after investigation of one size of unit.

Then substituting values in the basic equations,

$$S = \frac{\frac{1}{4} \times \frac{D^2\pi}{4} \times 600 \times K_l D}{.1(K_d D)^3}$$

$$= \frac{600 \times \pi \times 10 \times K_l}{4 \times 4 \times K_d^3}$$

or

$$S = 375 \frac{\pi K_l}{K_d^3}$$

Thus it is evident that for constant ratios d/D and l/D, S also is a constant and when the ratio l/D is kept constant it is rational to make the crank pin diameter a fixed percentage of the cylinder diameter.

Crankshaft in Torsion

The diesel engine with its sustained constant pressure phase brought in the necessity of considering the twisting stresses.

For a multicylinder solid injection engine the maximum tangental pressure is about 275 pounds per square inch of piston area. This results in a twisting moment

$$M_t = \frac{D^2\pi}{4} \times 275 \times \frac{s}{2}$$

where $s/2 = r =$ the crank radius.

If the stroke bore ratio is made constant for a proposed series of engines as $s/D = 1.25$, we may say,

$$M_t = \frac{D^2\pi}{4} \times 275 \times \frac{1.25\,D}{2}$$

The section modulus for torsion $I_p/a = .2d^3$ a being the cross sectional area of crank pin and I_p the polar movement of inertia; or if the shaft diameter is the same as the crank pin diameter,

$$\frac{I_p}{a} = .2\,(K_d D)^3$$

and

$$S = \frac{M_t}{\frac{I_p}{a}} = \frac{\frac{D^2\pi}{4} \times 275 \times \frac{1.25\,D}{2}}{.2K_d^3 D^3}$$

$$= \frac{\frac{\pi}{4} \times 275 \times \frac{1.25}{2}}{.2K_d^3}$$

or

$$S = \frac{675}{K_d^3}$$

Thus it also is quite rational to vary the shaft diameter directly with the bore. This conclusion will not be changed by investigation of the effects of combined stresses.

In like manner it may be shown that the bearing lengths for shafts of like design are directly proportional to the cylinder diameter.

If a unit pressure of 1500 pounds per square inch is desired in designing the crank pin its projected area will be 600/1500 = .4 times the piston area. Its length b then will be

$$b = \frac{.4 \times \frac{\pi}{4} D^2}{K_d D} = \frac{.314\,D}{K_d}$$

Many designers make the intermediate crankshaft bearings the same length as the crank pins.

The crank arms next may be analyzed for bending. Arm section modulus against bending the flat way will be

$$\frac{I_{xy}}{c} = \frac{1}{6} xy^2$$

in which $x =$ thickness of slab, $y =$ width of arm.

The moment arm l_1 in bending is measured from the center of the crankshaft bearing to

Fig. 2—Bedding a pair of 8-cylinder crankshafts for 1500-horsepower engines

the neutral axis of the arm. Since the crank pin and center bearing lengths are directly proportional to the cylinder bore as well as the total length l between each pair of center bearings it follows the room remaining for y also must be proportional to D and may be expressed:

$$y = K_y D \text{ and } l_1 = K_{l_1} D$$

We may assume that $x = K_x D$

The bending moment,

$$M_{b_1} = \frac{W}{2} l_1 = \frac{\frac{\pi}{4} D^2 \times 600 \times K_{l_1} D}{2}$$

since each arm receives half the piston load in cantilever fashion.

$$\frac{I_{xy}}{c} = \frac{K_x D \times (K_y D)^2}{6}$$

$$S_1 = \frac{M_{b_1}}{\frac{I_{xy}}{c}} = \frac{\frac{\pi}{4} D^2 \times 600 \times K_{l_1} D}{2} \times \frac{6}{K_x D \times K_y^2 D^3}$$

$$S_1 = \frac{450\,\pi\,K_{l_1}}{K_x K_y^2}$$

The terms in the equation all being constants

the transverse static stresses will be constant in the arms of any series of shafts in which the arm slab dimensions are fixed simple ratios of the cylinder bore.

The Rational Flywheel Formula

In torsional vibration the shaft is a torsion spring loaded with a series of masses, usually flywheel, cranks, reciprocating parts, etc. The rational flywheel formula is

$$w = \frac{g\,R\epsilon\,PsA}{f\,V^2}$$

in which w = the weight in pounds reduced to the radius of gyration of the rim.

$R\epsilon$ = the ratio of excess energy to the mean energy as shown by the turning effort curve. It is constant for each cylinder arrangement in any series of engines if the inertia values are the same, which is a possible achievement.

P = the M.E.P. developed in one power cylinder.

s = the stroke in feet and with a fixed stroke bore ratio a straight line function of D, the bore of the cylinder.

Thus $s = K_s\,D$, A = the piston area or $\pi/4D^2$, f = the coefficient of irregularity, usually a constant for any given class of service.

V = the flywheel rim velocity in feet per second at the radius of gyration of the rim and usually is constant for any series of engines as it is economical to use the greatest velocity consistent with the wheel construction. Marine engines are an exception to this on account of space but even then the wheel diameter often is made a fixed ratio to either bore or stroke. g = 32.16 feet per second per second.

With values chosen for these factors we may then derive a single constant embracing all of them and write $w = K_w\,D^3$, since all of the terms are constant except A which varies as D^2 and S which varies as D.

Let J_w = the mass polar moment of inertia of the flywheel in pounds feet squared. Then:

$$J_w = wr^2 = K_wD^3 \times \left(\frac{K_sD}{2}\right)^2$$

or

$$J_w = K_J\,D^5$$

In the same way crankshaft masses have been shown to vary as the cube of D since they are directly proportional in three dimensions to D. So also are the reciprocating parts of the rod and the piston and rotating part of rod roughly proportional in weight to D^3 for the same reason.

We then may write for the summation of the $w\,r^2$ values on the crank shaft system, $J_c = K_c\,D^5$.

Then in the expression for the period of free vibration of a system of two masses on a shaft with a node between, assuming the crank system considered as one equivalent mass and the flywheel another

$$T = \frac{2}{r^2_s}\sqrt{\frac{2\pi o}{G}}\sqrt{\frac{J_c\,J_w}{J_c + J_w}}$$

We find that r_s^2 = shaft radius squared, may be written $K_r\,D^2$.

Also o = the distance between oscillating masses, may be written $K_o\,D$ since the cylinder centers are proportional to D and the flywheel offset well may be the same.

The modulus of elasticity G is a constant for any one material so the whole expression may be written for any set of assumed conditions,

$$T = \frac{2}{K_rD^2}\sqrt{\frac{2\pi K_oD}{G}}\sqrt{\frac{K_c\,D^5\,K_w\,D^5}{K_c\,D^5 + K_w\,D^5}}$$

For the sums, products, roots, etc. of constants we may substitute another constant $K\epsilon$. Then,

$$T = \frac{K\epsilon}{D^2}\sqrt{D}\sqrt{\frac{D^{10}}{D^5}} = \frac{K\epsilon\,D^{1/2}\,D^{2\frac{1}{2}}}{D^2}$$

$$= \frac{K\epsilon\,D^3}{D^2} = K\epsilon D$$

That is, T is proportional to D or the frequency of vibration of the shaft with its loading varies inversely with either bore or stroke.

To sum up, if one has a series of engines to design with a chosen stroke bore ratio common to all and with a common ratio of cylinder spacing to cylinder diameter, the shaft and pin diameters properly are a fixed percentage of the bore and the critical speeds of any one order will vary inversely as the bore or stroke.

Some questions may arise regarding matters that have been reserved to avoid complicating the treatment. They are anticipated in the following.

The crankshaft length is not considered equal to its dimensional length in these calculations. An equivalent length, usually greater, is substituted allowing for the greater torsional flexibility of cranked shaft. The ratio of actual to equivalent length remains equal for a series of shafts of the same straight line proportions if the usual semi-empirical formulas may be trusted at all. In carrying out the method in practice no grief has resulted.

Low Frequencies Are Obtained

The method of treating the cranks and reciprocating masses as one equivalent mass results in frequencies slightly too low. If the aim is to avoid all destructive vibration in the range from zero to full speed of the engine, a critical at a speed slightly higher than calculated obviously cannot be harmful.

There are no practical difficulties in the way of straight line proportions for shafts. It tends to order in the design process and a pleasing appearance of proportionality in the finished series of engines.

This analysis indicates the possibility of testing shaft models and complete torsional system models of more complicated form to determine critical speeds, equivalent lengths and the like prior to the construction of the massive full size system.

Mounting Heavy Duty

Fig. 1—Bar mill with bearings mounted as shown in Fig. 2

APPLYING antifriction bearings to the type of machine implied in the terms "heavy duty" is not a particularly easy matter. It has been brought to its present stage of development only after a considerable amount of experimental work and some bitter experience. During the earlier stages, both bearing engineers and machine manufacturers learned a good deal about heavy duty machines that neither of them knew before. As a result, however, it has been possible to standardize mountings for even the most difficult applications to some extent, and also possible to formulate a more or less general set of rules of procedure that fit most cases.

Mounting Design Vies with Selection

These rules come into effect largely after the selection of the bearing according to capacity requirements has been made, for even if the proper capacity has been selected, the design of the mounting has much to do with its ultimate performance. In other words, it is possible for operating conditions to have even a greater effect on mounting designs than they have on bearing capacity. This probably can be brought out much more clearly from a consideration of a few specific examples involving the use of tapered roller bearings. It might be said that the same general principles would apply in the case of any other type of bearing found suitable for the service.

Probably the most outstanding example is the application made to the roll necks of steel mills of the type shown in Fig. 1. This particular application is striking because of the magnitude of the loads encountered and the difficulty in meeting certain service requirements. Since these requirements have influenced the design of the mounting to a considerable extent, it might be of interest to outline them briefly before describing the mounting itself. First, the rolls must be held rigidly in spite of the heavy, fluctuating loads, so that pass alignment will be maintained positively. Provision must be made for thorough lubrication at slow speeds and under varying conditions of temperature. And any possibility of water or scale entering the bearing boxes must be eliminated, since these are about the most destructive agents to which the bearings could be subject. Finally, there must be a certain degree of facility in assembly and disassembly on the neck. The mounting developed to meet these requirements is shown in Fig. 2.

The bearing cones, or inner races, are fitted loosely on the roll neck, being clamped on it against a fillet ring by a keyed spacer and a special locking ring. To eliminate the necessity for threading the neck, a groove is cut in

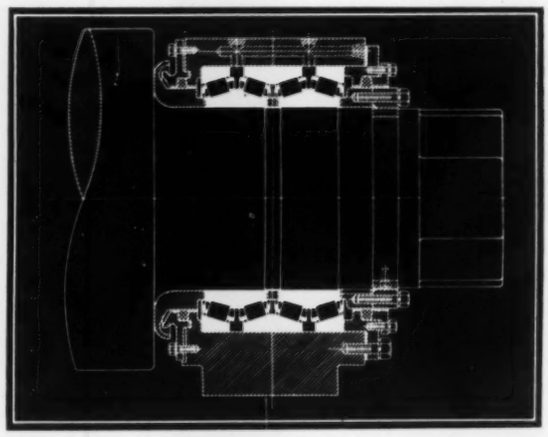


Fig. 2—Typical bearing layout for steel mill roll neck

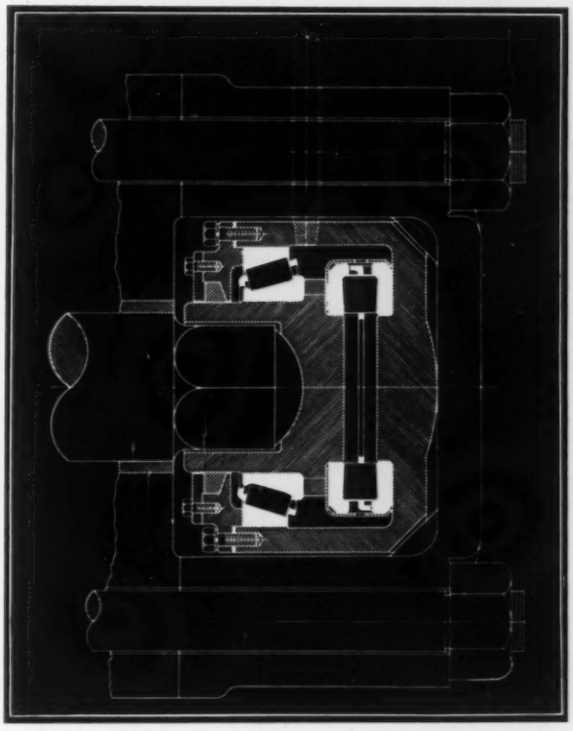


Fig. 3—Mounting for thrust bearing on a horizontal shaft

Roller Bearings

By S. M. Weckstein

FAILURE of antifriction bearings in service rarely is encountered where contingencies are provided for by the design of the mountings. For this reason the author of the accompanying article, who is associated with Timken Roller Bearing Co. as industrial engineer, has detailed the procedure to be followed in sound mounting design, particularly for heavy duty applications.

it into which is fitted a split, threaded ring so designed that it need not be removed when the bearing is taken off the neck. Thus the entire bearing can be removed without disturbing the bearing set-up, simply by taking off the nut on the split ring. The cones are separated by a spacer ring that is ground at the factory and shipped as part of the bearing. In assembly this ring is piloted on one of the cones so that it cannot slip out of position and prevent the bearing from sliding onto the neck easily.

Cups, or outer races, are given a loose fit in the housings and are set up by means of shims between the housing and the outer end cap, the set-up being made before the bearing is slipped on the neck. The required number of shims for each size of bearing is specified by the manufacturers. Since it has been established that wear in the bearings is slight, it has been found possible to supply bearings that are completely set up, with the required looseness, at the factory. This is accomplished by means of cup spacer rings, ground accurately to size and assembled between the cups.

As has been stated, the design is influenced by the lubrication requirements of the service. In the particular case, grease is used as a lubricant, being forced into the bearing chamber through inlets between the bearing cups that connect with individual ducts bored in the housing. If spacers are used, the rings are grooved and bored at short intervals so that the lubricant can go through them. In the cone assembly, the cone spacer ring, fillet ring and locking ring adjacent to the clamping nut all have from 6 to 8 notches about an inch wide and $\frac{1}{8}$-inch deep cut in the faces that are in contact with the cones. The notches allow lubricant to work down the faces and thence under the cones, providing a film between the cones and the neck that reduces scuffing and wear to a minimum. It can be seen that the closures are elaborate, as a necessary precaution against the entrance of water or scale. Either felt or metallic packing is used and wherever possible glands or similar arrangements are supplied that permit taking up on the packing. In the best practice all surfaces on which the packing bears are made concentric, and ground and polished so as to reduce packing wear as much as possible. As an additional precaution the inner closure, where conditions are naturally worst, is provided with a flinger to assist further in keeping water and scale out of the bearings.

Lubricant Leakage Is Serious

Heavy duty rubber mill machines also offer interesting problems of design. While the loads, sustained or peak, are not so heavy in these cases they come well within the range of heavy duty, usually being in excess of 200,000 pounds per neck. Great attention must

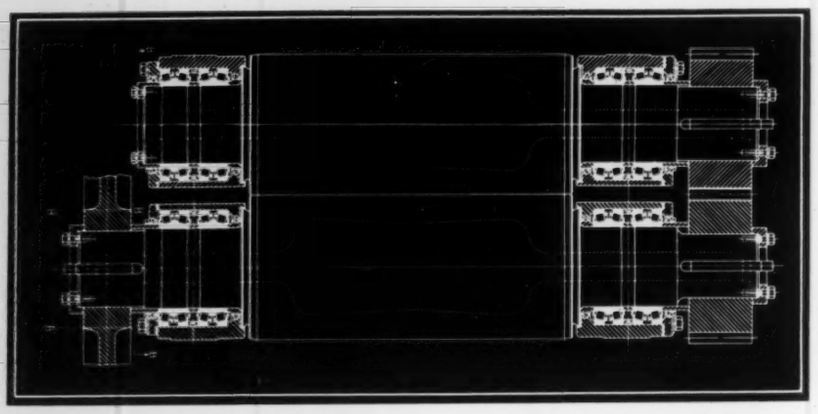


Fig. 4—Bearing arrangement used on rolls of rubber refiner

be paid to lubrication, in fact the difficulty of properly lubricating plain bearings is one of the factors that is causing the change to anti-friction bearings in these machines. In this instance, however, it is more a problem of keeping the lubricant in the bearing box than keeping out foreign matter. Lubricant leakage in a rubber mill can destroy more valuable material than it can almost anywhere else. Since the main features of mounting design are similar for mixer, refiner and Banbury rolls, the mounting designed for refiners will serve to show how the general problems are met. A typical arrangement for this service is shown in Fig. 4.

Two double row bearings are used at each end of the roll, so that there is sufficient bearing area to allow an even distribution of load pressure. The bearing cones are given a light fit on the neck, the inner one being adjacent to a fillet ring that serves to locate it. The cones are separated by a spacing ring that also is given a light fit on the shaft as are the cups in the housing. Bearing assemblies at each end are adjusted separately, different methods being used where gears or pinions are mounted on the neck from those where the neck dead ends. In the former case a spacer is placed between the gear, or pinion, and the outer cone, so that when the gear or pinion is seated properly the bearing assembly is located correctly.

In the case of the dead end neck a cap, whose inner circumference fits against the bearing cone, and which is bolted to the neck serves the same purpose as the gears. The bearing cups are adjusted separately by means of shims between the housing and the outer closure. This constitutes a rigid mounting and, since some provision must be made for roll expansion, a clearance is left between the bearing block and the pedestal. As a result, when the roll expands the whole block can go with it and there is no danger of binding or disturbance of the bearing adjustment. The closures are comparatively simple but it can be seen that considerable precaution has been taken to prevent the escape of lubricant, especially on the roll side of the mounting. As is the case in all or nearly all heavy duty mountings, grease is used as a lubricant and storage area is provided for a considerable quantity.

Roll Rigidity Is Essential

Differing in several respects from that just described is the mounting for calenders, shown in Fig. 5. In this case the matter of holding the rolls rigidly to predetermined settings is of paramount importance and that of retaining the lubricant is almost as important. Both of these requirements are reflected in the mounting. Four rows of rollers are provided at each end of the roll to distribute the load pressures as evenly as possible. The cones are given a loose fit on the neck and spacers ground accurately to size are put between them.

The assemblies at each end are adjusted in much the same manner as a steel mill bearing. That is, a threaded split ring fits into a slot in the neck and carries a solid ring which presses on a spacer ring between itself and the outer bearing cone, thus locking the whole assembly in place. This forms a rigid mounting such as is necessary to maintain the close roll settings required to keep an even gage of the material being calendered. At the inner end of the mounting is a forging press-fitted on the shaft, machined to provide a wide annular recess. The housing proper is provided with a flange, or rib, that extends into this recess and a felt ring is fitted in a groove in the outside diameter of the flange to make a

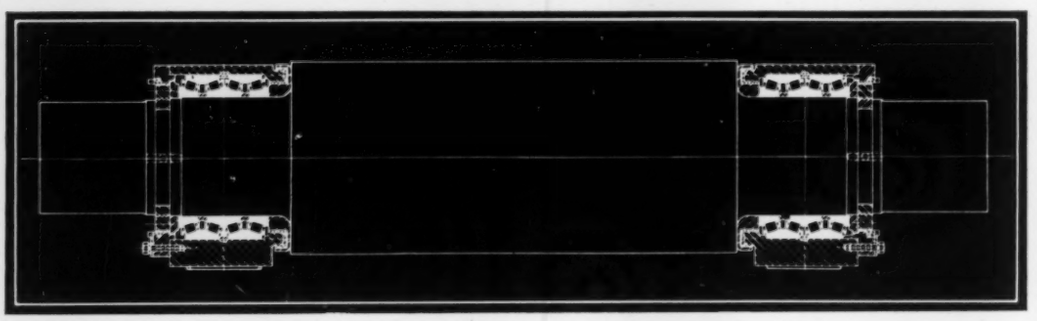


Fig. 5—Mounting developed for the rolls of a rubber calender. Note the double seal at inner closures

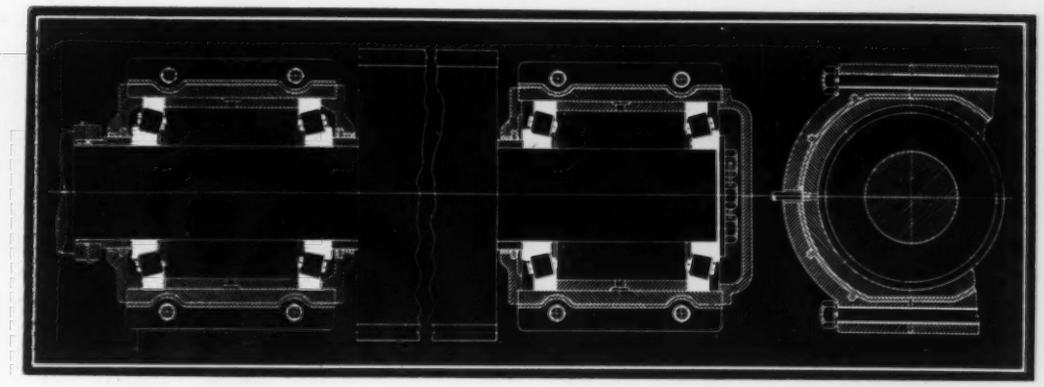


Fig. 6—One type of mounting employed for the pug mill shaft of a brick machine. Thrust loads as well as radial are provided for

rubbing contact with the inner surface of the recess. This construction prevents the escape of any lubricant. The outer closure is comparatively simple, consisting of annular grooves in the closure plate and a felt ring at the outer edge that can be compressed to compensate for wear by screwing in a follower.

Another class of application where most of the characteristics and working conditions vary considerably from those described is that made

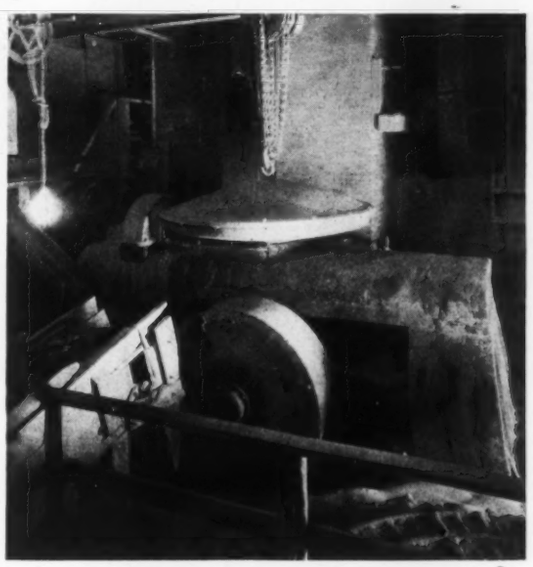


Fig. 7—Large dry pan using step bearing mounting shown in Fig. 9

to heavy duty shafts. Typical instances would be pug mill shafts on brick machines, crusher or hammer mill shafts, heavy duty drive shafts, and the like. Generally speaking all such mountings have many requirements, and consequently many features in common, hence a few of them will serve to show how the problems involved are met in practice. Take for example, Fig. 6, which shows the mounting developed for the pug mill shaft of a brick machine. In this case the thrust loads are fairly heavy because of the reaction of the pug paddles against the clay. Some provision must be made for shaft expansion, and positive means must be adopted for keeping dirt or dust out of the bearing boxes.

In this particular case, bearings are used that have capacity for heavy thrust, as well as radial loads, so that there is a high factor of safety either way. The bearings are mounted in cartridges, which are babbitted firmly into the pedestal boxes to prevent any possibility of misalignment. Shaft rigidity is provided for by fixing the bearings of one mounting, and shaft expansion or compensation for inaccuracies in machining are provided for by allowing the bearings at the other end to float in the cartridge. At one end the bearings are set up by means of an end plate and shims at the end of the shaft, and at the other by means of a threaded sleeve located between the outer bearing and a shoulder on the shaft. This arrangement is adopted to cut down machining expense by eliminating the operation of threading the shaft. It can be seen that ample space is provided for lubricant storage and that the closures, though comparatively simple, are designed to be effective in preventing the entrance of dust or other foreign matter.

Designing for Heavy Thrust Load

In the instances described hitherto it can be assumed for the sake of argument that the radial component of the load exceeds the thrust component, even if only slightly. There is another class of heavy duty application, however, where conditions are reversed. That is, where the thrust component exceeds the radial to a degree where the latter becomes practically negligible. Such cases call for a design of mountings so different that they deserve individual consideration. Two general types of mounting have been developed to meet the requirements in these cases which, while different in several respects, usually attain the same end. The choice between them is settled principally on the merits of the particular case in hand, but their comparative value as a solution for certain more or less conventional problems in loads and design best can be seen from a discussion of their individual characteristics. One is applicable in cases where, although thrust loads predominate, there is still an appreciable amount of radial load that must be taken care of. The other is used where the loads are, to

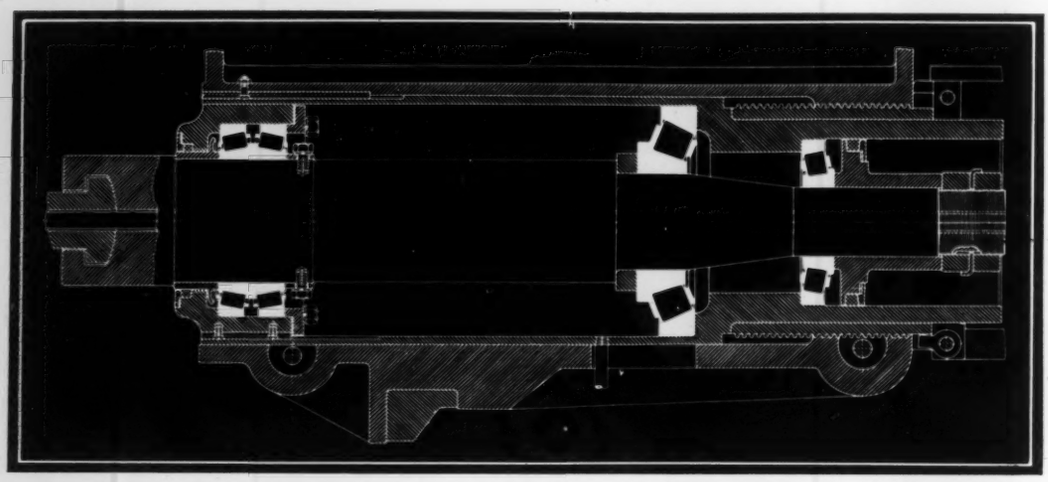


Fig. 8—Type of thrust mounting where there are also appreciable radial loads to be considered. The thrust capacity of the center bearing is greatly in excess of its radial capacity

all intents and purposes, purely thrust.

An example of what may be called the first method is shown in Fig. 8, this illustrating the thrust block for a piercing mill. In this case the thrust loads are heavy. Matters are complicated further by the presence of a radial load, caused by the whip of the plug rod, that must be taken into consideration. This mounting has been developed to take care of all of the contingencies involved. The radial load is carried by the double row radial bearing located at the front of the block, which is mounted so as to impart as much rigidity as possible to the shaft. The heavy thrust load is carried by a bearing whose thrust capacity exceeds its radial capacity. Pressed on the shaft, the cone bears against a spacer that locates it with respect to a shoulder on the shaft and the cup is pressed directly into the housing. This arrangement is such that the whole thrust load is transmitted directly to the strongest portion of the block itself.

The small opposing thrust bearing is provided to carry the thrust loads arising when the plug is backed out of the tube. Generally speaking its mounting is similar to that of the large bearing, it being locked firmly in place by means of a spacer, which forms its outer closure and an adjusting nut pinned to the shaft. Lubrication is provided by an oil bath in the block, so that a rather complicated closure design is necessary to prevent the escape of lubricant.

Cartridge Mounting Is Employed

For the second variety of applications, where the loads are practically all thrust, a mounting has been developed using a tapered thrust bearing. An example of such a mounting, as applied to the auger shaft of a brick machine, is illustrated in Fig. 3. In this case, the bearings are mounted in a cartridge, so that the whole forms a self-contained unit, easily assembled on the shaft. The cone of the radial bearing, which incidentally acts merely as a guide bearing, and the inner race of the thrust bearing are pressed onto an adapter that fits over the end of the shaft. The adapter is made self-aligning for reasons that are obvious. The cup of the radial bearing is given a light fit in the cartridge, and the outer thrust bearing race is seated in the cartridge, a slight clearance being allowed in the bore to prevent binding and misalignment with the other race. Shims are used between the outer closure and the cartridge, and the latter is prevented from rotation by slots cut in its outer edge which engage heavy webs cast in the head of the block. Oil lubrication is employed in this mounting and usually some variety of stuffing gland closure is used on that account. This is necessary to keep out clay and dust which has a tendency to work along the shaft and into the bearing box.

Fig. 9 shows how this type of mounting can be adopted for use as a step bearing for a vertical shaft. Most of the details are exactly the same, the few changes consisting of a two part adapter, doweled to prevent slippage, and the tight fit of the lower bearing race on the bed

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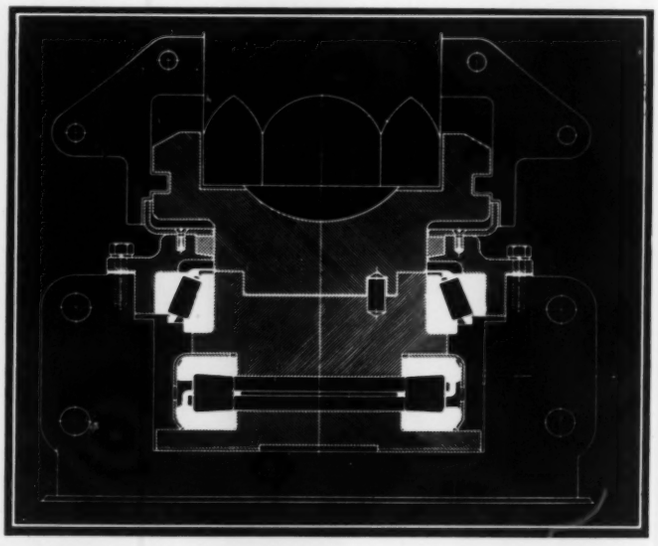


Fig. 9—A step bearing for a vertical shaft

Rare Metal Has Many Unique Properties

By C. W. Balke

AS APPLYING to the element tantalum, the term "odd" well might be used. Yet this metal possesses many valuable characteristics and offers numerous possibilities in design. Dr. Balke, research director, Fansteel Products Co., Chicago, touches upon these in the accompanying comprehensive and timely article.

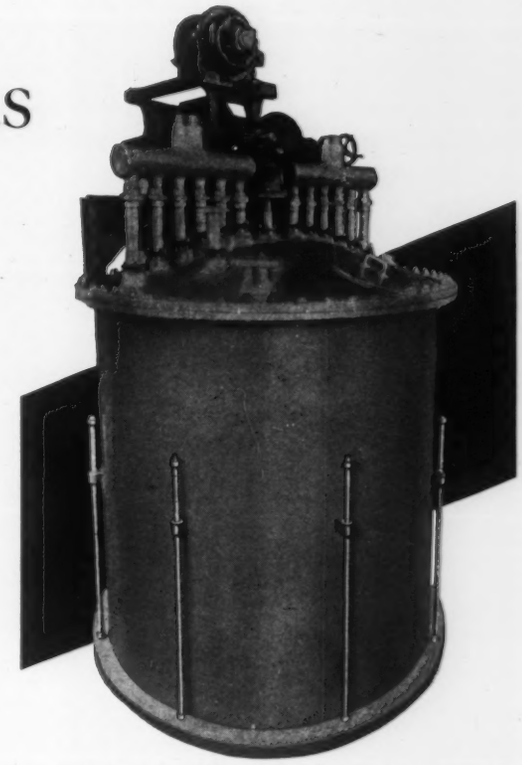


Fig. 2—Contamination is guarded against by the use of tantalum in this phenol still

WITH the exception of those who are on the firing line and in close touch with the problem, few people realize the extent of industry's battle against corrosion. It is estimated that one hundred million dollars are paid out annually to replace equipment, piping, containers and vulnerable parts which have been attacked by corrosion.

Outside of the industry that produces chemicals are dozens of others which use corrosive substances as part of their products or processes. These industries also are afflicted with "trouble spots" where corrosion either makes equipment extremely short-lived, or disturbs the uniformity of the product by contamination.

The equipment designer, therefore, is expected always to keep an eye not only on the immediate material and manufacturing costs, but the ultimate sales and service costs as well. And where corrosion is concerned, the material he selects for vulnerable parts is an important factor. These things directly influence sales, the reputation of the house, dealer satisfaction and net profits.

An example bringing out the importance of selecting the right material is found in the rayon industry. In the viscose process there is a step where liquid viscose, or cellulose, in a highly corrosive alkaline state, is forced through tiny holes in small, thin metal shells. These parts are known as spinnerets and are illustrated in Fig. 1. The streams of viscose pass through the holes into sulphuric acid, forming the fibres which subsequently are spun into threads. The spinnerets, immersed in the acid, are subject to attack from acid on the outside and alkali on the inside. At the same time there is a certain amount of mechanical wear or erosion from the viscose, tending to enlarge or distort the shape of the holes.

For a long time an alloy of platinum and gold was considered the only material capable of withstanding this punishment. But spinnerets of this alloy were expensive and usually

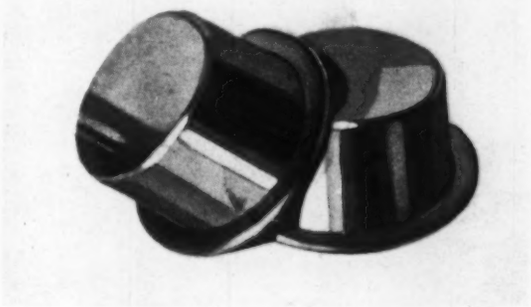


Fig. 1—Spinnerets used in rayon industry. Liquid cellulose forced through holes in these parts hardens into fibers which subsequently are spun into threads for rayon production

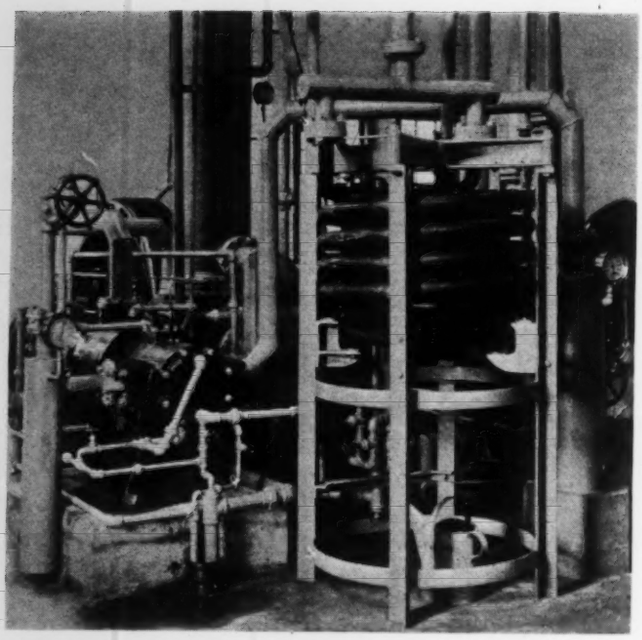


Fig. 3—Corrosion is resisted in hydrochloric acid condensers by employment of tantalum for tubing or tube lining

were too soft to withstand the mechanical wear. As the tiny holes wore larger continual replacements were necessary, with the result that the development engineers searched for a better material. Tantalum eventually was tried and proved to be entirely successful.

The term "corrosion resisting" is misleading, for all materials resist corrosion to a certain degree. It is only when a material is inert, or so nearly inert that a lifetime of service may be obtained, that such a material may be considered for use in vulnerable spots. Of the materials in this classification, tantalum is worthy of due recognition. It is finding increasing use in numerous fields and few metals offer so many interesting possibilities.

Tantalum is number 73 in the Moseley series, with an atomic weight of 181.5, density 16.6, tensile strength, in the form of wire, 130,000 pounds per square inch, and a melting point of about 2850 degrees Cent.

Columbium Discovered in Same Ore

The existence of this material was noted first in 1802 by Ekeberg who found it in the same piece of ore in which Hatchett, the previous year had discovered the sister element, columbium. This is the natural occurrence of these metals. When the ore contains more tantalum than columbium it is called "tantalite," or when the percentage of columbium is the greater, "columbite."

Australian tantalite is essentially a columbate and tantalate of iron. The ore often contains as high as 80 per cent Ta_2O_5, and is an iron salt of tantalic and columbic acids. Small amounts of titanium, tin and tungsten almost invariably are found to be present in the ore.

After others had devoted a century to unsuccessful efforts to refine the metal, Von Bolton in 1903 developed a process for producing a ductile form of tantalum capable of being drawn into fine wire for use as lamp filaments. Tantalum was the first metal used commercially as filaments, and from 1905 until 1911 a large number of tantalum lamps were made both in Germany and in the United States. Pieces of the sheet metal could not be produced large enough however, to make it of much practical, commercial value.

In 1920 the company with which the author is associated instructed him to concentrate on this problem and granted him facilities with which to work. After months of constant effort to produce a ductile metal in large pieces, a sample was obtained that could be passed through a rolling mill repeatedly and rolled down to a thin sheet without developing cracks or strains. Production was begun shortly after, and tantalum began to be marketed in bars, rods, sheets, wire, shapes and tubing.

As refined today, the metal is rated by the United States bureau of standards as 99.9 per cent pure. It looks somewhat like tin plate, but with a slightly bluish cast, and takes an excellent polish.

The outstanding chemical property of tantalum is its inertness to most forms of corrosion.

TABLE I

Corrosion Data on Tantalum in Form of Sheets, Wire and Bars

Sulphuric acid, dilute, or concentrated and below boiling point	E
Nitric acid, dilute or concentrated	E
Hydrochloric acid, dilute or concentrated	E
Aqua regia	E
Hydrofluoric acid	P
Hydrofluoric and concentrated nitric mixed	P
Acetic acid, 10% solution or concentrated (glacial)	E
Formic acid, 12% or 50% solution	E
Oxalic acid, 10% solution	E
Phosphoric acid, 10% or 85% solution	E
Carbolic acid, 5% solution	E
Citric acid solution	E
Tannic acid, 15% solution	E
Sodium acetate, 20% solution	E
Iodine solution, 10% solution	E
Chlorine solution	E
Sodium hydroxide, dilute solution	G
Sodium hydroxide, hot concentrated	P
Potassium hydroxide, 10% solution	E
Ammonium hydroxide	E
Sea water	E
Sea air	E
Moist atmosphere	E
Moist sulphurous atmosphere	E
Mine waters	E
Gases containing carbon monoxide	E

Note. E, excellent: Resistance to corrosion of such degree in laboratory and service tests that long life is assured. G, good: Commercially long life obtained. P, poor: Material is useless.

It is not attacked by hydrochloric or nitric acid, nor even by aqua regia, which dissolves gold or platinum. Nor is it attacked by dilute or concentrated sulphuric acid at ordinary temperatures. Boiling concentrated sulphuric appears to attack the metal slowly. Hot concentrated caustic seems to be the only alkali which will attack it to any measurable extent. Gases, either in a gaseous state or in solution have no effect upon it at ordinary temperatures, except in certain cases when under the influence of electric current.

Hydrofluoric Attacks Metal Slowly

Hydrofluoric acid, which readily dissolves glass, is the only reagent to which tantalum is really vulnerable and when both metal and acid are pure, even its action is slow. A mixture of hydrofluoric and nitric acids, however, attacks tantalum rapidly, forming a fluoride salt.

In its commercial form the metal is extremely ductile when worked cold, and may be hammered, rolled, machined, formed and drawn. It takes a permanent set in stamping, with no springing back from the dies. It is possible to roll a bar of tantalum 0.4-inch thick to a sheet 0.001-inch thick without intermediate annealing and the sheet may be bent upon itself at right angles to the direction of rolling. Longitudinally the sheet may be somewhat brittle, but upon annealing, a disk may be cupped and drawn to the form of a capsule 3/16-inch diameter by 1⅛ inches long. The capsule can be drawn further to a tube having an outside diameter of 0.050-inch. The material welds readily to itself and to practically any other metal by either resistance or arc welding.

By a simple electrolytic process, tantalum may be colored in a variety of irridescent hues which often are worked into beautiful effects. This has created a demand for the material as an art metal although it has not yet reached the position occupied by gold or platinum. Manufacturers who use tantalum in their products or processes often color the metal to identify it, for with the single exception of columbium no other material may be colored in this fashion. The coloring appears to be an oxide film, formed by electrolytic action. This film is hard and durable and is as inert to chemical action as is the metal itself.

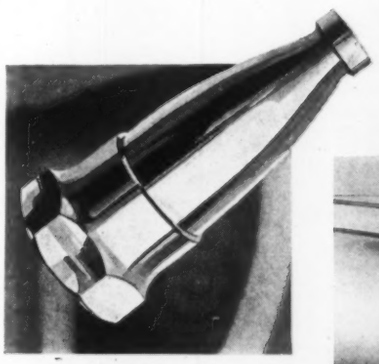
The action of tantalum on being heated is remarkable. When steel is heated in air and allowed to cool slowly, it anneals. Tantalum is diametrically opposite, for when heated in air to about 600 degrees Fahr. it becomes exceedingly hard. At higher temperatures the metal burns. In a vacuum, however, or in the presence of certain gases it may be heated to a degree close to its melting point and under such conditions exhibits properties which make it useful in vacuum and discharge tubes.

The reason tantalum must not be heated in air to more than a dull red is that it absorbs gases. It will take up 740 times its own volume of hydrogen, producing a coarse-grained, brittle substance. The process of annealing it consists of driving out occluded gases, which is done by heating the metal in a vacuum. Samples of tantalum will vary from an actual brittleness to a condition of lead-like softness according to amount of gas present in the metal. The commercial annealed metal is of about the hardness of annealed copper, while the regular "run of the mill' is about as hard as mild steel.

Provides Electrolytic Valve

While experiments to produce commercial tantalum were being conducted in the laboratory, it was noted that it acts as an electrolytic valve —that when a piece of tantalum and a piece of some other metal, such as lead, are placed in an acid electrolyte and an alternating current applied, the current will flow from the lead to the tantalum, but not backward. Other metals posses this "valve" property, but tantalum is the only valve metal immune to the corrosive action of the electrolyte.

The noncorrosive advantages of tantalum rapidly are being put to work, the metal being used as lining for equipment, piping and con-



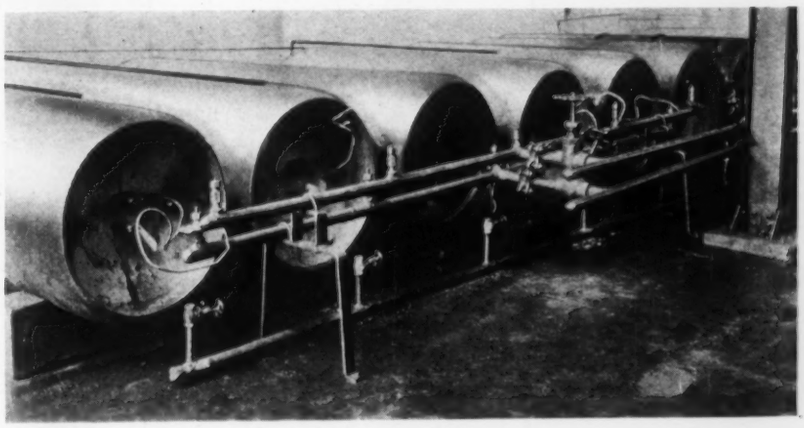


Fig. 4—(Above)—Complete inertness to wet chlorine gas is offered by tantalum nozzles. Fig. 5—(Right) — Chlorine gas cylinders

tainers. While it costs considerably more than the alloys commonly used for such purposes, it should be remembered that tantalum affords permanent protection against corrosion where other materials are "corrosion resisting" only, with eventual replacements inevitable. In view also of its high ductility and strength a relatively low investment in the metal, where weight is considered, will cover and protect a large area.

Tantalum offers possibilities for use in filters and screens. It can be drawn into fine wire and woven as easily and accurately as brass or copper, and sheets can be perforated. Such filters and screens may be cleaned by immersion in acid, and will last indefinitely since the acid has no action whatever upon the metallic structure.

Valve parts, nozzles and fittings made from tantalum are used with much success. Innumerable other applications also could be referred to where the employment of this metal effects improvements and is a profitable investment. It is suggested, however, that the designer consider its possibilities in relation to his own process or product. Summing up briefly, the material is inert to all acids except hydrofluoric and all alkalis except hot concentrated caustic. It can be used at any temperature below 600 degrees Fahr.

Presents Corrosion Data

Table I, which shows the resistance of tantalum under the action of various chemicals. Both gaseous and liquid was worked out by the committee of the society for testing materials. The ratings given are conservative and represent corrosion data for the metal as far as the facts have been determined. Many of the tests were made by immersing tantalum sheets, sometimes partly exposed to air, in the reagents shown for a period of fifty days. In the tests graded "Excellent," the metal showed no gain or loss in weight at the end of that period. In similar tests where the sheets were immersed in a 33 per cent solution of potassium hydroxide for 120 days, they showed a discoloration but practically no change in weight.

TABLE II

Technical Characteristics

Atomic number	73
Atomic weight	181.5
Density at 20°C	16.6
Atomic volume	10.9
Tensile strength, lbs. per sq. in.	130,000
Compressibility per unit volume per kg/cm²	52 x 10-6
Brinnell hardness at 500 kg.	45.9
Scleroscope hardness	10
Young's modulus of elasticity, kg. per sq. mm.	19,000
Melting point °C.	2850
Boiling point °C.	4100
Specific heat cal. per gm. per °C, at 0°C.	.0365
Linear coefficient of expansion per °C.	6.5 x 10-6
Thermal conductivity in cal. per cm² per sec. per ° at 18°C	.130
Heat of combustion cal. per gm.	827
Heat of combustion cal. per gm. atom	300,120
Temp. coefficient of resistance at 20°C.	.0031
Electrical resistance microhm per cm. cube at 20°, annealed	15.5
Magnet susceptibility	+93 x 10-6
Electrochem. equiv. mg. per coulomb	3762
Refractive index	2.05
Thermo-electric E. M. F. against copper, micro-volts per degree	4.1

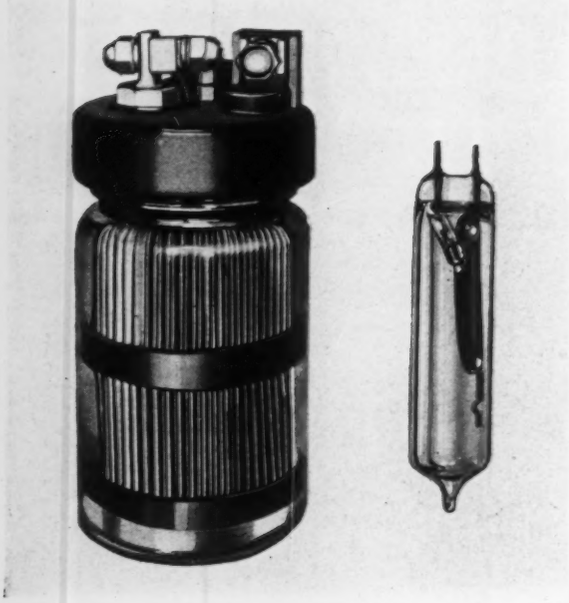


Fig. 6—(Left)—Electrolytic condenser in which tantalum is used as a "valve." (Right)—Mercury switch with electrode of same material

Light Metals Group Is Formed

FORMATION of a light metals group, with the Aluminum Co. of America as the first member, recently was announced by the American Standards association. This group becomes the forty-fifth member-body of the association with representation on the American Standards association standards council. The council now includes organizations of national scope representing a large proportion of the major branches of the manufacturing, mining, and public utility industries, national engineering societies, and several departments of the federal government.

It is expected that the creation of the light metals group will stimulate greatly the establishment of national standards and specifications covering the processes and products of the light metals industry, which include aluminum and magnesium, their alloys, and alloys of these metals with others.

A Study in Friction Drives of Loaded Drums

By Wm. A. Rosenberger
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A LOADED drum driving arrangement used frequently in certain industries is illustrated diagrammatically in Fig. 1. It consists of a steel drum D with tires E supported by driving rollers B and idler rollers C. The latter either may turn loose on shaft G or be keyed to this shaft which, in turn, may revolve in bearings F. For one particular instance considerable trouble was experienced with slippage between drive rollers B and tires E causing the drum to stop while rollers B kept

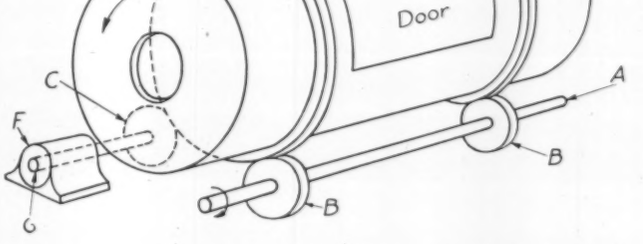


Fig. 1—Diagram of general arrangement showing drum, friction tires and driving rollers

revolving. Due to the fact that the drum was equipped with a dump door through which the load was discharged upon completion of the operation, the shafts A and G had to be spaced a certain distance apart so as not to interfere with the discharge of the load (Fig. 2), while the same door served for charging the drum, when in position shown in Fig. 3. All kinds of theories were advanced and suggestions made for overcoming the difficulties caused by slippage but all of these suggestions were matters of personal opinion without sufficient scientific background and no guarantee that their adoption would correct the trouble. The matter thus was permitted to drift along, costing the manufacturer a handsome amount yearly for service expenses, not to speak of the loss of prestige.

It is the writer's belief that engineers in many fields are interested in just such problems, taken from actual practice. A brief approximate analysis of this particular case therefore is offered in the following.

Let D = diameter of drum tire
d_1 = diameter of driving rollers
d_2 = diameter of idler rollers
d_3 = diameter of idler roller bearing (shaft)
W = total load
c = eccentricity of center of gravity
F = driving force
R = retarding force (due to bearing friction)
a, b, α_1, α_2, a^1, b^1 are distances and angles shown in Fig. 4
μ = friction coefficient between drive roller and tire
μ' = friction coefficient in idler roller bearing.

It is apparent that, to cause the drum to revolve, the movement of F in a counter clockwise direction must be equal or larger than the sum of all the movements acting in a clockwise direction, or:

$$F\frac{D}{2} \gtrless Wc + R\frac{D}{2}$$

However: $F = \mu P_1$ ..... (2)

and $P_1 = W_1 \cos \alpha_1$

Similarly: $R^1 = \mu' P_2$

or $R = R^1 \frac{d_3}{d_2} = \mu' P_2 \frac{d_3}{d_2}$ ..... (3)

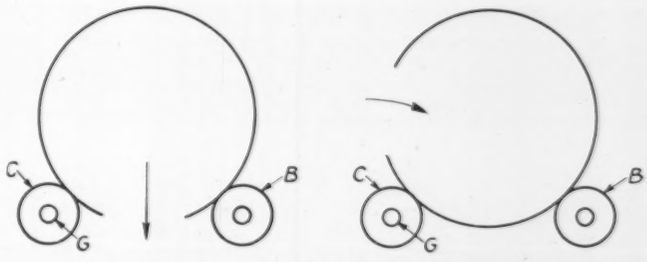
and since $P_2 = W_2 \cos \alpha_2$

we find, by substituting in (2) and (3)

$$F = \mu W_1 \cos \alpha_1 \quad \text{..... (4)}$$

$$R = \mu' W_2 \cos \alpha_2 \frac{d_3}{d_2} \quad \text{..... (5)}$$

Now, W_1 and W_2 easily can be determined as the reactions in contact points A and B of a beam



Figs. 2 and 3—Sketches indicating unloading and loading positions respectively

A-B loaded by a weight W in a plane going through center of gravity *S*.

Thus: $$W_1 = \frac{Wb^1}{a^1 + b^1} \quad \text{.....(6)}$$

and $$W_2 = \frac{Wa^1}{a^1 + b^1} \quad \text{.....(7)}$$

Substituting these values in formulas (4) and (5) and these in turn in formula (1) we find:

$$\frac{\mu b^1 \cos \alpha_1 D}{2(a^1 + b^1)} \leqq c + \frac{\mu' a^1 \cos \alpha_2 d_2}{d_2 (a^1 + b^1)} \quad \text{.....(8)}$$

This then is the condition for assuming rotation of the drum under all conditions, and we note first, that the weight of the drum and load have no bearing in the matter only insofar as

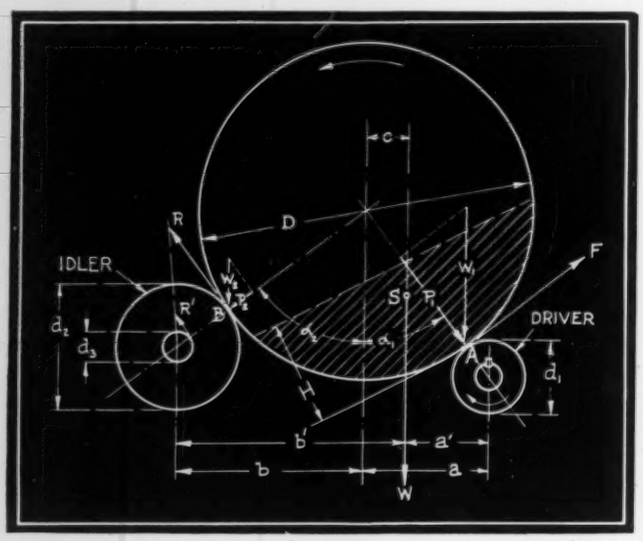


Fig. 4—Showing eccentricity of center of gravity and forces acting with drum loaded

the position of the load inside the drum affects the eccentricity *c* of the center of gravity.

Analyzing further equation (8), it is obvious that any factor tending to increase the left hand expression will contribute to the security of the drive as will any factor tending to decrease the value of the right hand side of the equation.

Considerations for Positive Drive

The factors making this drive more positive are therefore:

1—Large friction coefficient μ between drive roller and tire (avoid oil, provide sanding device.)
2—Make distance b^1 (and b) as large as possible.
3—Keep angle α_1 as small as possible.
4—Increase tire diameter D if possible.
5—Avoid continuous longitudinal load lifting cleats inside of drum, which tend to raise load thus increasing eccentricity *c*. If cleats are necessary to cause load to tumble, apply staggered, short cleats.
6—Decrease bearing friction of idler rollers.
7—Increase diameter of idler rollers.
8—Make angle α_2 as large as possible. This can be accomplished by supporting idler rollers on short, stationary shafts which do not project into the door opening on each side.

A comparatively simple reflection will show that the eccentricity *c* may be expressed in terms of friction coefficient between load and inside of drum, as follows:

$$c = \frac{D}{2} \frac{\mu''}{\sqrt{1 + \mu''^2}} \left(1 - \frac{H}{D}\right) \quad \text{.....(9)}$$

where H represents the depth of the load with the barrel at rest. While this formula may not be strictly scientific, it will be noted that the maximum eccentricity *c* occurs when $H = 0$ and the minimum, or $c = 0$, when the drum is fully loaded $H = D$, in which case the center of gravity of the load W^1 coincides with the center of the drum.

For example, assume a drum 30 inches in diameter 1/3 full, or $H = D/3$ and a friction coefficient $\mu'' = .60$ (increased on account of work tumbling cleats inside of drum) then:

$$c = 15 \frac{.6}{\sqrt{1 + .36}} (1 - .33) = 5.16'' \text{ approx.}$$

Since the loading conditions are generally known, we can figure the approximate eccentricity from formula (9). If this value is introduced in formula (8) and it is found that the left hand side is equal or smaller than the right hand side, it will be necessary to resort to a positive drive of idlers *C* (Fig. 1).

Metal Specifications Are Tentative

AT THE suggestion of the joint committee of the American Society for Testing Materials, the Nonferrous Ingot Metal institute has sponsored a research associate at the bureau of standards to study certain of the alloys within each of the classifications of nonferrous ingot metals with the object:

1. To provide the industry with more complete information regarding alloys in use.

2. To be used as a guide in greatly reducing the number of alloys used.

3. To be used as a guide in revision of present American Society for Testing Materials specifications.

Based upon the survey, American Society for Testing Materials committee B-5 on copper and copper alloys, cast and wrought, completely revised the specifications for brass ingot metal to include a more extended list than in the previous specifications and to formulate more practical and workable specifications. The list includes 15 alloys. It is believed that these may be used in place of more than 600 alloys now in use by industry. These specifications are published as tentative.

Conserving Space by Multiple Production

By Edward Heller

CONSERVATION of space is illustrated to a marked degree in the design of a special machine developed recently for one of the largest automobile manufacturers in the country. The unit is a four-station automatic indexing machine designed to spot, drill and tap forged clevises four at a time at three sations, with the fourth station as the loading and unloading position.

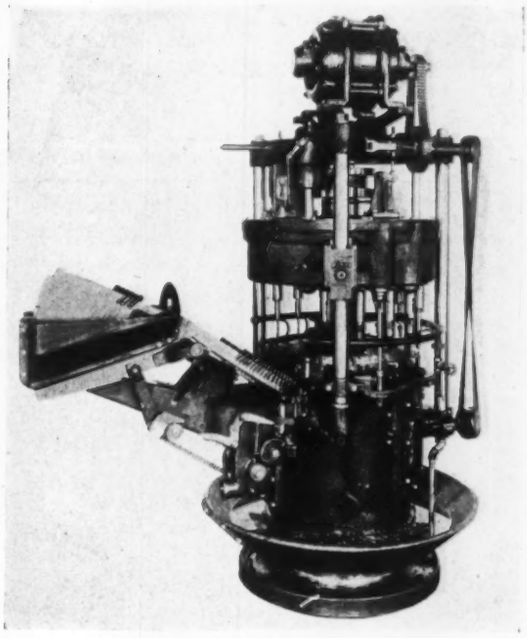


Fig. 1—General view of the machine showing hopper at left

If made according to sound engineering principles for production singly of small parts such as these clevises, the proportions of the machine would be far too large. It therefore was decided to make the machine quadruple, instead of single. Thus the unit spots, drills and taps four clevises at every quarter turn of the table.

This, in a measure, compensates for lost time due to inequality in the operations. Spot drilling takes the least time, while the drilling of the hole through a depth of about ¾-inch takes the longest; so the spotting and tapping operations must mark time during the drilling.

As will be gathered from Fig. 1, the machine, built by Sommer & Adams Co., Cleveland, consists essentially of a hopper for the clevises; an intermittently rotating table; a drill head which carries the spot drills, drills and taps, and a cam mounted on the vertical center shaft for imparting up and down motion to the drill head. Fig. 2 shows a general section of the machine taken through the drive, feed and indexing mechan-

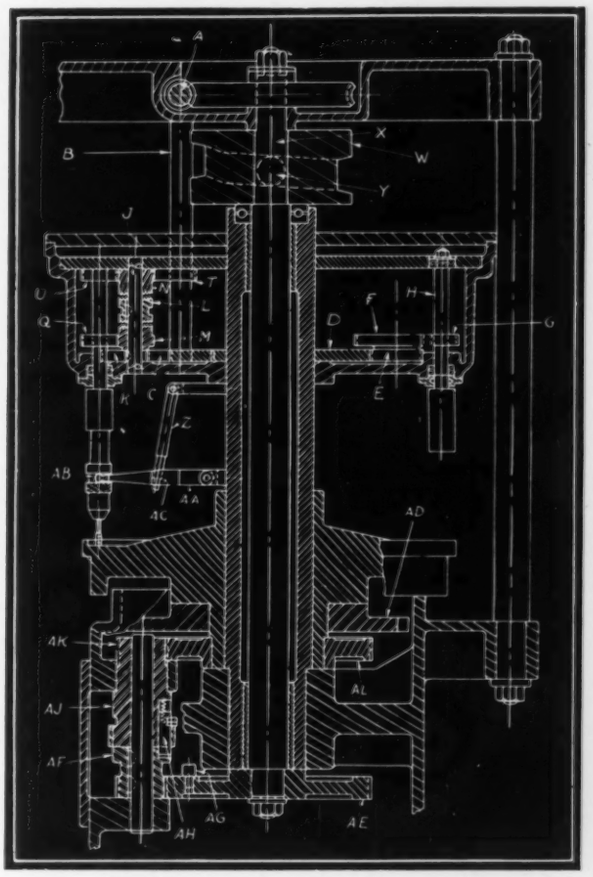


Fig. 2—Cross section through operating mechanisms

isms. The motor on top of the machine in Fig. 1 drives shaft *A*, Fig. 2. At the further end of the shaft, a bevel gear engages with another at the upper end of shaft *B*. This shaft carries a spur pinion *C* at its lower end, which drives a bull gear *D*, and from there all the drills and taps derive their respective motions.

Taps Reverse Through Clutch

All drill spindles are driven in pairs, so that only four sets of intermediate gears, shown at *E* and *F*, are required to drive the eight drills. A more elaborate system of gearing is required, however, to operate the taps, due to the fact they have to be reversed. In this case the bull gear drives a clutch shaft *J* through the pinion *K*. Forward and reverse rotation is imparted to the tap through pinions *M* and *N* respectively and the other taps operate at the same time through interconnecting gearing. Engagement of the clutch takes place during the feeding movement of the head through an arrangement of bell cranks and levers.

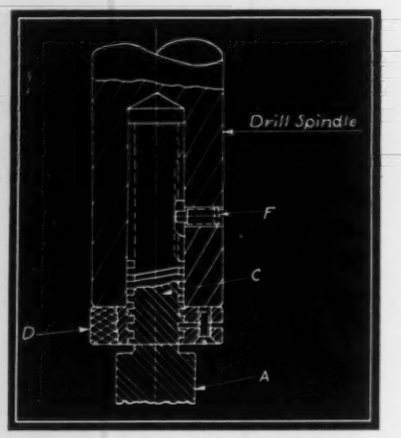


Fig. 3—For adjusting the drills when ground down, a drill chuck with square-threaded shank is used

The feeding of the entire drill head is accomplished through cam *W* on the main vertical shaft *X*, which is driven through the worm and worm gear at its upper end. This shaft makes one revolution for every quarter run of the table. The cam has a rapid approach, and a feed suitable for the drills. Originally the taps were held in floating chucks backed up by heavy springs to help them catch the first few threads, but this method was not satisfactory as the taps often would spoil a few threads at the top before cutting properly. To overcome the trouble the link *Z* and lever *AA* were added, the link being fastened to the bottom of the drill head, and the lever pivoted to the stationary center column.

Points *AB* and *AC* are at such a ratio that as the drill head travels downward at a speed suitable for the drills, the taps are pushed down with a feed exactly the lead of the thread being cut. As the tap moves down, link *Z* ceases to engage with it and the tap is free to feed itself is due to the lead of the thread. On reversal the link again connects with the lever and the arrangement is ready for the next cycle.

For rotating the table the vertical shaft *X* carries a gear *AE* at its lower end, which meshes with the pinion of the lower clutch member *AF*. At every revolution of the gear a pin *AG* kicks a lever (not shown), which causes Key *AH* to drop down into a pocket in the clutch member. In this way the two sections of the clutch *AF* and *AJ* are united, causing pinion *AK* to revolve the table gear *AL* one-quarter of a revolution. The clutch on this machine is of a similar type to that used on punch presses, i.e. after one revolution is completed the clutch disengages and will not operate again until the driving pin comes into contact with the operating lever.

Fig. 3 shows the method used for adjusting the drills for length. The drill is held in a simple sleeve chuck *A*, the shank *C* of which is threaded the full length with a square thread upon which the split adjusting nut *D* is screwed. After adjustment the nut is locked in place with a flat-headed screw. The chuck is held in the spindle by means of the dog point set screw *F* which tightens in a slot having a two-degree taper. The square thread leaves sufficient surface on the shank to keep it in alignment at all times, and the shank is hardened to prevent damage to the threads.

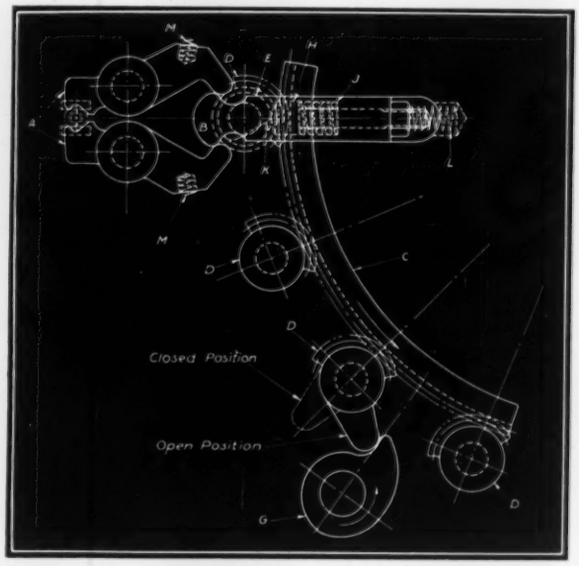


Fig. 4—Section of ring gear, pinions and clamping mechanism for the clevises

Fig. 4 shows at *A*, one set of the chuck jaws and at *B* the plunger that spreads the inner ends of the jaws for clamping the forgings while they are carried around under the various tools. At a lower level in the table four gear segments *C* are held loosely, each against four pinion segments *D-D-D-D* which are keyed to the ends of the cams *E*. One of these segments has a tail. After the forgings are loaded into the open

chuck jaws, the cam *G* makes one revolution and turns the tail to the postion shown by the dotted lines. This motion moves the segment *C* in the direction of the arrow, which turns the other three cams and pushes plungers *B* toward the center of the machine, locking the four chucks. The cam *E* does not come in contact with the plunger *A* proper, but with a stud *H*, backed up by a heavy spring *J*. The slight movement that is possible between the plunger and stud takes care of any variation in the neck diameters of the forgings.

These complete assemblies are carried round intact on all four sides of the table until passed the taps, when a stop strikes the tail and brings it back to the original open position. The small springs *M-M* collapse the jaws, and the finished parts drop down to a delivery chute.

Some of the details of this machine, if it were built in large quantities, probably could be improved upon, this applying to details of appearance as well as construction. Nevertheless, the mechanism and movements as designed have proved successful with the few changes and additions that were found necessary to the original layout.

Design Trends Characterize Engineering Exposition

POWER is the force behind every mechanical operation; therefore it is significant that an exposition of ways and means of generating, transmitting and applying it should command the attention of leading men in all phases of the engineering industry. The recent Power show brought together thousands of engineers to study the remarkable progress in design.

UNLIMITED application of electrical control apparatus was indicated at the Ninth National Exposition of Power and Mechanical Engineering held recently in New York. A large percentage of nearly every type of machine shown makes use of this class of equipment, and at the show more manufacturers of such devices were represented than at expositions held in former years. From the operation of small machinery such as exhibited, to the control of millions of tons and gallons of fuel, these control units play a vital part. With the advent of a higher type plant, a robot almost insofar as the elimination of manual labor is concerned, a tremendous field is opening up for electrical equipment. Observers found among the interesting new devices, a thermostatic regulator which operates on a variation of 1/10 degree. It was arranged to start a fan and is adaptable to many industrial uses.

The prevailing lull in business has given added impetus to the development of a number of new mechanical units, many of which were shown for the first time at the exposition. A small noncondensing steam turbine for driving pumps, fans and similar industrial equipment was a feature of one of the exhibits. This unit employs a new centrifugal governor with weights pivoting on knife edges to operate with little friction and provide proper speed regulation.

Welding and the part it is essaying in industry was indicated impressively. One exhibitor displayed three new types of welding machines. Oxyacetylene welding and its applications was the theme of another department of the show. Special emphasis was given to the use of this type of fabrication in the installation of power piping and construction of pressure vessels.

Lubricating equipment was another section in which the march of progress in design has effected remarkable changes. Automatic and centralized lubricating systems were much in evidence. Electric motors of all descriptions and sizes constituted another of the leading attractions and the influence of the practice of building the motor into the machine was seen clearly in the new designs developed to meet this requirement. Gears, pumps, water softeners and pulverizing units added to the variety of exhibits.

Exhibits Include Special Alloy Steels

Special alloy steels also were shown, revealing that this material is gaining ground rapidly in the industry. A new machine was exhibited for cutting steel, steel alloys, iron, nonferrous metals, fiber and other materials. The cutting time is measured in seconds instead of minutes and heat is not a damaging factor. Moving parts are balanced and the motor is fastened to the bed of the machine, so that it is not a part of the counter-balancing arrangement.

Power transmission with short center drives was demonstrated, and silent chain drives, flexible couplings, speed reducers, disk and ring oilers and accessories also were shown. Considerable study was devoted to the development of an improved automatic ring oiler which was displayed in operation under glass.

Featuring one of the antifriction bearing ex-

(*Concluded on Page* 54)

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments from Our Readers. Machine Design Will Pay for Letters Suitable for Publication

Preserving Valuable Drawings

To the Editor:

THE writer's article on the above subject in September MACHINE DESIGN elicited some comments from John F. Hardecker regarding the "personnel" and "organization" section, in that he states his observations have led him to the belief that girls rather than boys are best suited to handle the filing and recording work involved in the systematic care and utilization of tracings. In this connection may I not suggest that Mr. Hardecker and other readers concerned in this phase of engineering department work might be interested in my experience in this matter?

After a period of approximately 2 years, during which time girls were employed for this work, the writer came to the conclusion that we would benefit by reinstating our previous policy of utilizing boys, providing they were hired with a view to potential possibilities, not solely on mere qualifications for the immediate position. Consequently we have adopted a definite policy of employing a certain number of "apprentices." All are required to be high school graduates and those desiring to follow drafting and engineering as a vocation are further required to complete a correspondence school course within a given period of time. For the proper execution of home study, as well as work in the department, they are offered regular periodical raises in wages. Falling below predetermined standards, necessitates withholding wage increases until requirements are fully met.

An additional inducement is held forth in that a bonus is paid at the completion of the 3-year course. By that time the boys are fully trained in the "trade" they have elected to follow. At first we experimented with only those aspiring to become draftsmen, but the success of the plan led us to include also those thought better fitted to follow activities requiring skill in the manufacturing divisions. This procedure has furnished the means of our being supplied with carefully picked boys who are of the highest type, intelligent and ambitious.

Lack of space allotment for my first article prohibited covering this subject in detail, as well as many other kindred subjects such as the timely suggestion by Mr. Hardecker, which also appeared in your "Professional Viewpoints" column (October issue) regarding improved wear and dirt resistance on pencil cloth drawings through the medium of the application of a thin spray of lacquer.

—E. L. CHEVRAUX,
South Bend, Ind.

Larger Suction Than Discharge

To The Editor:

RECENTLY the question "Why are centrifugal pumps manufactured with larger suction connection than discharge connection by most manufacturers?" arose and no agreement could be reached between myself and associates. I therefore attempted to explain the matter in the following way.

All velocity generated in the pump requires equivalent head energy to generate this velocity. The energy is expressed by the well known formula $V^2 = 2gh$, where V = velocity in feet per second; H head in feet; $G = 32.2$.

To demonstrate the practicability of making the suction larger than the discharge, take for example a standard 4-inch pump which has a 4-inch discharge and 5-inch suction. Assuming the pump is being used for a capacity of 700 gallons per minute, the velocity in the suction as the pump is built, namely, 5-inch diameter, would be 11.44 feet per second. To generate this velocity according to the formula given above, a two foot head is necessary. In other words, two foot is the suction lift which the pump must generate to accelerate the water in the suction line to the velocity of 11.44 feet per second (if the water is taken from rest). It now is assumed that the pump is built with only 4-inch suction. The velocity would be 17.85 feet per second. To generate this velocity it would require 5-inch energy.

A most important reason for having larger suction is when handling hot water, oils, gasoline or other liquids that are liable to vaporize. When the suction lift necessary to generate this increase in velocity required by smaller suction is applied to the liquid, there is a tendency for it to vaporize and the vaporization, of course, depends on the liquid tension of the liquid being handled. Rapid vaporization results in the pump becoming vaporbound with consequent decreased capacity or complete dropping of the suction.

Of course there are examples where various velocities in suctions are used, but the leading pump manufacturers have found that in most cases it is more practical and better results are obtained where larger suction than discharge is used.

—R. H. PARRISH,
San Antonio, Tex.

Clean Out Active Files!

To the Editor:

THE article "Good Filing Equipment Saves Time and Money," by E. L. Chevraux in October MACHINE DESIGN, deals ably with a timely subject which too often is neglected in the average engineering department. I agree heartily with all that is said, but feel that in addition to equipment, wear and tear on the tracings also be minimized by certain more indirect considerations.

Well directed executive attention often may be applied profitably in checking over the contents of the active tracing file. Drawings of obsolete parts or models, or even obsolescent parts or models, continually should be weeded out of active files. Nothing destroys tracings more quickly than crowding. These removed tracings, assuming they still have some value, real or potential, are best stored in pigeon holes in a vault or other reasonably accessible safe place.

Proper administration also will insist on a well-kept blueprint file not only for its own sake but as tracing insurance. There exists no easier path to the cultivation of the habit of asking for the tracing for reference by draftsmen than a blueprint file that cannot produce a print promptly on request. This means not only having borrowed prints returned promptly, but also keeping those returned filed up at all times. Anyone forced to wait while a clerk checks an unfiled pile of prints for the print that isn't in file, knows how trying this can be. A large letter size file, with blueprints folded accordion fashion so that any part of the print may be examined readily without opening it up, is the best file practice for blueprints.

—LEWIS J. YAPP,
Collingswood, N. J.

Shop Contact Is Advantageous

To The Editor:

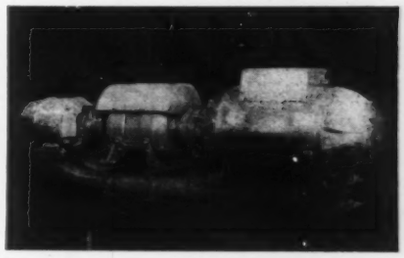
MAY I add my comments to those of Mr. Kaufman which appeared in MACHINE DESIGN for October under the heading "Practical Aspect of Design?" Having served a number of years in the shop in different capacities before entering the field of design, I value those years as a real asset. Contact with the shop is of value because, as a design is developed, the various machining operations more readily can be visualized and the designer is enabled to make things less difficult for the tool room.

There is a practice which I think should be encouraged more than it is, and that is permitting men to leave the board once a day at least to go out into the plant to make observations on various operations. It not only is refreshing to have a respite, but it gives a stimulus for the work in hand. I have seen this worked out with good results and am satisfied that if more plants would try it they would find it a paying venture. In order to check results of plant observations report slips could be issued and a record kept.

—CHAS. T. PLASTOW,
Cleveland

Pipe Is Arc Welded for Base

PIPE construction bed plate is employed to advantage in the small motor-generator set shown in the accompanying illustration. The tubular lengthwise members especially resist torsional strains, such as those due to uneven and yielding foundations. Welded tubular designs provide strong and rigid structures at considerable savings in weight. The set was built by Westinghouse Electric & Mfg. Co.



Arc welded pipe base for motor generator set to be used on a ship

MACHINE DESIGN

Editorial

Seize the Opportunity—Merchandising Methods Are Changing

AT FIRST glance the statement by qualified authorities that meat and many other food products soon will be offered for sale in drug stores seems to have no significance whatever to the machine design profession. From drug store counter to the drafting room appears to be a far cry indeed.

But if we will take the trouble to look behind the scenes in the food industry we will find much of interest to designers of machinery. The old methods of food distribution have been inefficient. Speculation has thrived on waste, and producers, distributors and consumers alike have suffered.

Today there is a definite trend toward the preservation of foods to avoid waste in the handling of so-called perishables. You now can purchase delicious fresh strawberries in certain drug stores. A year from now you will be able to buy a package containing two, three or six or more pork chops—or units of cuts of other meats.

These modern miracles are made possible by refrigerating and packaging equipment. As the new methods of distribution gain popularity the demand for automatic packaging machines will increase. New ideas of merchandising will be developed in which the engineers who design wrapping and container machines should participate.

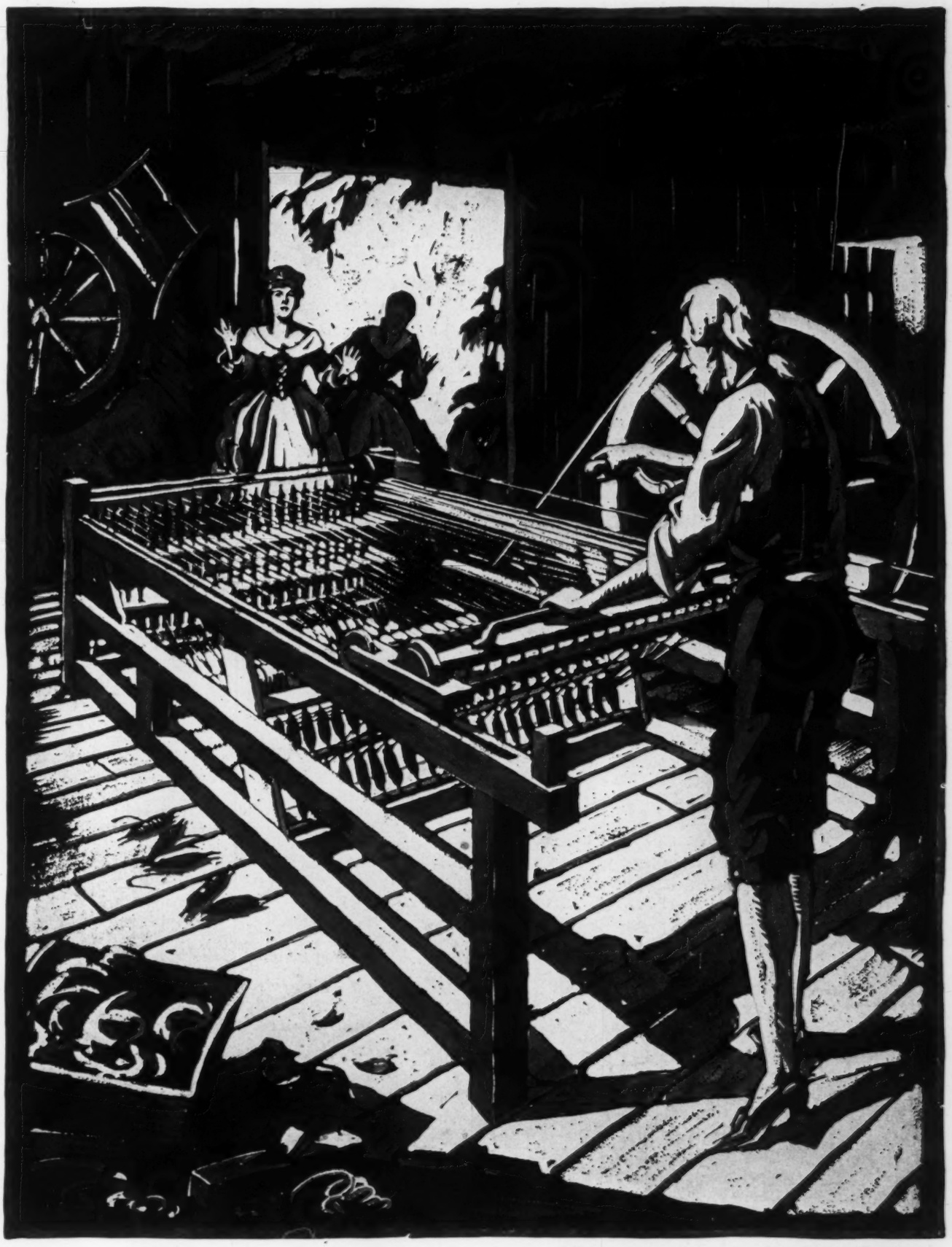
Here is an almost virgin field of opportunity. The food industry undoubtedly will turn more and more to machine designers for assistance in their new merchandising plans. The design profession should be eager and ready to co-operate.

A Sign of the Times

IT IS significant to note that design executives, development engineers and others responsible for design increasingly are being accorded due credit. That their work is being recognized as never before by their associates in the engineering profession is unquestionable.

As a particular instance substantiating this, attention is drawn to the recent annual meeting of the American Society of Mechanical Engineers in New York. Papers and discussions dealing with numerous phases of design work were more prominent at this meeting than at those of former years and interest in this subject was much more pronounced.

Significant also is the increase in the number of expositions being held or to be established in larger cities in which progress in design is featured strongly. Added to this is the fact that, as mentioned on page 54 of this issue, leaders in the field of engineering are referring more and more in addresses made at celebrations and other functions to the work of the design profession.



Hargreaves and the Spinning Jenny

Great Moments in Machine Design—Sixteenth of a series of original drawings prepared exclusively for this magazine symbolizing the designer's contributions to the progress of mankind

NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

EMBODIED in a newly patented variable speed friction drive are interesting design features which provide a novel means of obtaining a change in the rotating velocity of a driven shaft. Carrying United States patent No. 1,775,201, this device was conceived by R. S. Jacobsen who has assigned it to J. F. S. Co., Chicago. In brief the object of the invention is to furnish improved construction and means to attain variable speed by the employment of spheres having frictional contact with other elements of the unit.

In the accompanying illustrations Fig. 1-*A* is a section of the friction drive variable speed gear; *B*, also shown in Fig. 1, is a detail showing one of the spherical friction elements adjused to reverse the drive; Fig. 2-*C* shows a side elevation of the outer casing; Fig. 2-*D* is a transverse section on line 4-4 of *A* in Fig. 1.

Power is furnished by the motor 1, on the shaft of which is a friction drive pinion 3 as shown in *A*, Fig. 1. Housing 4 provides a bearing 5 in which the short shaft 6 is mounted to rotate, this shaft carrying inside the housing a large friction bevel gear 7.

Axes 12 are provided with rock shafts having their middle portions formed with bearings 13 on the axes 11. Bolts 16 can be tightened to vary the coil springs 18 which force the balls or spheres 10 against the beveled peripheries of the friction pinion 3 and friction gear 7. Bevel gears 20 connect the axes 12 together at their ends, and an outside crank arm 21 is applied to the projecting end 22 of the axes. Adjustment of this crank or hand lever serves to rotate all of the balls or spheres 10 in unison about their transverse axes 12, thereby changing the speed of the drive.

The operation of the device may be seen by referring to Fig. 1-A. If the ball shown is tilted downward at its left side, the speed of gear 7 will be increased, but if this ball be tilted upward at its left side, then the speed of the gear 7 will be decreased. By adjusting the handle to the proper extent, the spheres can be made to assume the position shown in *B*, Fig. 1, so that their axes 11 will extend radially of the shaft 12, instead of parallel, thereby reversing the drive.

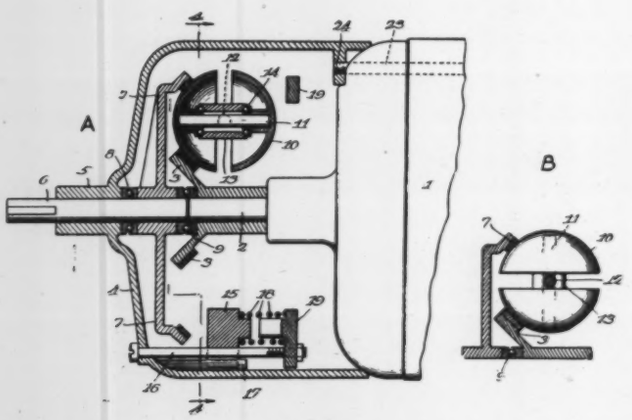


Fig. 1—A—Section of the variable speed device showing one of the spherical frictional elements. A sphere adjusted in position to reverse the drive is shown at B

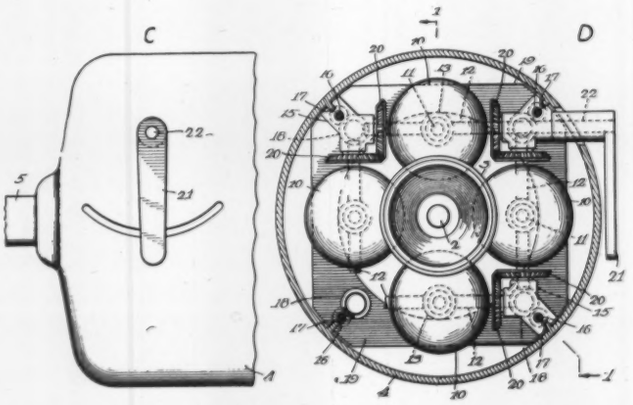


Fig. 2—C—Side elevation of the outer casing. D —Arrangement of the spheres and means for adjusting them. A hand lever serves to rotate all spheres simultaneously

ONE of the interesting patents granted recently covers a flexible coupling which connects two rotatable elements in such a manner that their axes can be displaced relative to each other without impairing the effectiveness of the driving connection between them. Robert G. Anderson, Colonie, N. Y., devised the mechanism and General Electric Co., Schenectady, N. Y., is the assignee. The patent No. is 1,780,105.

Fig. 2 shows *A* as a transverse section of a locomotive or car embodying the invention, partly broken away to show the construction. *B* is a side elevation and *C* shows a modification of

the coupling between the driving wheel and the driving gear. Motive power is furnished by a unit such as a twin motor 13 having pinions 14 engaging a driving gear 15 secured to quill shaft 16, which surrounds axle 11 and is carried by bearings 17 extending from the frame of the motor.

The motor, gear and quill shaft constitute a unitary structure in which the motor pinions 14 are maintained in proper alignment with driving gear 15. In order to minimize the dead weight carried by the axle 11 this structure is supported on the main frame 18 by cross ties 18a. Springs 19 support the frame on axle 11. By this arrangement the frame with the unitary structure will move up and down or sway on the springs and move relative to the driving wheels and axle when the car passes over irregularities or curves in the tracks.

Links 23 extend between the spokes of the driving wheel 10 into openings 24 to form a connection with the driving gear. The necessary flexibility between links 23 and the driver 15 is obtained by forming balls 23b on the links, which are seated in sockets, and by the fact that members 21 are rotatable in their mountings.

MINIMUM lubrication is required by a universal joint recently patented by William J. Smith and Herman F. Braun and assigned to Cleveland Steel Products Corp., Cleveland. The patent No. is 1,778,170. Comparatively few parts, the principal ones of which are shown in

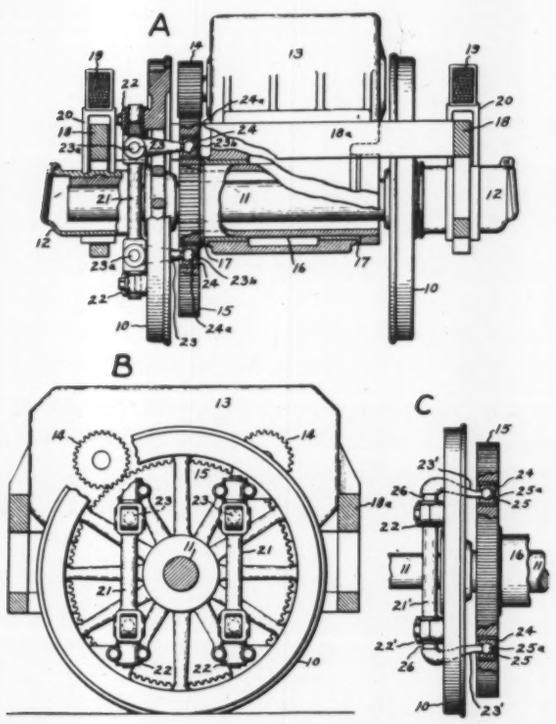


Fig. 3—*A—Construction showing the embodiment of flexible coupling. B—Side elevation of the structure. C—Modification of coupling between the driving gear and wheel*

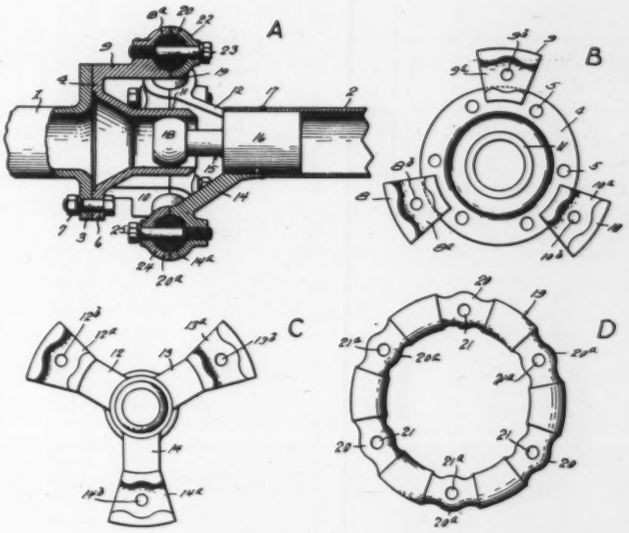


Fig. 4—A—Section showing details of universal joint. B—End elevation of one of hub sections. C—The other hub. D—Flexible member which provides driving connection

Fig. 4, are necessary in the construction of this unit.

Integral with annular part 4 are arms 8, 9 and 10. Constituting the opposite side of the coupling is hub 2, having arms 12, 13 and 14. Coupling member 15 is connected with hub 2 by its cylindrical portion. The other end of the coupling member is in the form of a truncated sphere 18 which has a working fit in projection 11.

Arms 8, 9 and 10 are provided with semispherical recesses; likewise arms 12, 13 and 14. The annular flexible member 19 forms the driving connection between the two hubs and at the same time permits them to be operated at an angle to each other.

Review of Noteworthy Patents

Other patents pertaining to design are briefly described as follows:

MECHANICAL MOVEMENT—1,778,901. This patent covers a movement embodying a to and fro movable element having two functioning faces in fixed relation to each other, a rotary element engaged by one or the other of the faces and moved step by step in either direction, according to the face that is functioning. Assigned to Hemphill Co., Central Falls, R. I.

ALLOY STEEL—1,778,226. "A steel alloy containing carbon 1 to 1.75, chromium 4 to 10, tungsten 6 to 10, vanadium 0.5 to 2 per cent as chief ingredients, and the principal part of the remainder being iron." Assigned to Barber-Colman Co., Rockford, Ill.

CLUTCH—1,782,572. "In combination, a driving shaft, a clutch member mounted on the shaft to rotate with it and having outwardly projecting teeth, an eccentric mounted about the shaft, an operating arm having a strap fitting the eccentric, and a pawl on the eccentric. The mechanism acts to prevent disengagement of the pawl tooth by the reaction

pressure exerted on the arm when the eccentric is moved beyond dead center. Assigned to Conlon Corp., Cicero, Ill.

CONTROLLING MECHANISM—1,782,618. A patent recently was granted for a mechanism to control paper strip on a paper tube making machine. The unit comprises in part an element from which strip is supplied to a mandrel and means for vertically adjusting the element. Assigned to Robert J. Jauch, Fort Wayne.

INDICATING MEANS—1,782,670. This invention is for application on weighing apparatus and is made up of an indicating chart and a transparent member in front of the chart to serve as a datum or reading line for the indications on the chart. Assigned to Adrianus Van Duyn, Rotterdam, Netherlands.

CAGE FOR BALL BEARINGS—1,783,141. This patent protects the invention of a ball cage for bearings, comprising a single wire bent into pocket forming loops opening alternately from opposite sides, the wire between each two adjacent loops being bent into a helix. Each two adjacent helices are capable of retaining a ball in the appurtenant pocket. Assigned to the Hess-Bright Mfg. Co., Philadelphia.

Design Trends Characterize Exposition

(*Concluded from Page* 47)

hibits was a setup to show the capacity of bearings for carrying thrust loads, as well as the reduction they effect in friction. It consisted of a steel mill bearing weighing approximately 500 pounds, mounted on a vertical shaft, the whole suspended weight being carried by a small bearing. The shaft was driven by a fractional horsepower motor, using a fish line for a belt. The show provided a complete assortment of the different types and sizes of plain and antifriction bearings manufactured by the various companies over the country.

Increase in the number of working exhibits was an outstanding feature and disclosed that more attention is being directed toward this manner of displaying mechanisms, machine parts and machinery. This was particularly evident in the special tool and machine tool section. In that department of the show the elimination of manual operation held the interest of visitors who saw what can be accomplished by the pressing of a button. These tools combined with gears, machine parts and the great volume of other mechanical equipment on display afforded an unusual study.

Concurrently with the presentation of the show were held the fifty-first annual meeting of the American Society of Mechanical Engineers and the meeting of the American Society of Refrigerating Engineers. Members of the engineering profession were keen to realize the value of the information gained by attending the technical sessions of these organizations and visiting the Power show.

Dedicatory Addresses Exalt Designers' Status

By Alexander W. Luce

Assistant Professor of Machine Design, Lehigh University

RECENTLY dedicated at Lehigh university, Bethlehem, Pa., the Packard laboratory was conceived to be the finest of its kind in the country. Ample time was taken for its careful planning, much of its early design being executed by the machine design staff of the university. When Mr. Packard's gift of $1,200,000 assured the erection of a laboratory, a year was taken to enable the architects to incorporate in the layout all of the features found desirable after a searching study of other plants.

It is gratifying to every man interested in design of machinery to note the high regard held for the designer as an essential part of the engineering industry as expressed throughout the various addresses of the three-day dedication. Dr. D. C. Jackson, head of the department of electrical engineering at Massachusetts Institute of Technology, expressed it when he said, "In the engineering schools we believe that engineering is second only to preventive medicine in influences which improve the comforts of populations and widen to all individuals the opportunities for desirable living."

Designer Is Foremost in Speeches

Due consideration was given the research and production men but again and again the designer appeared first in the speakers' thoughts. The importance of the designer often is overlooked because his success is taken for granted not only by the public but the engineering profession as well. That the engineer rarely is found wanting to meet the instant need of things is constant tribute to the sufficiency and effectiveness of his training.

Another significant thought in the addresses was the general call for sympathetic democratic graduates from our technical schools. Training in fundamentals rather than specialties is important. It was noteworthy that the ability to write a good letter or report or to persuade the acceptance of a sound design was considered to be of equal importance with scientific skill. What man in any design department has not had occasion to appreciate the truth of this?

A final thought of importance to machine designers was the expression, "There can be too much engineering in an engineering course." As designers we need the benefit of wider cultural training to enable us to make better designs as well as to make ourselves more essential, desirable and likeable personalities in our organizations.

ASSETS TO A BOOKCASE

Review of Books Pertaining to Design

Handbook Data Revised

Mechanical Engineer's Handbook, by Lionel S. Marks; leather, 2264 pages, 4½ x 7 inches; published by McGraw-Hill Book Co. Inc., New York, and supplied by MACHINE DESIGN for $7, plus 15 cents postage.

Tremendous development in the field of mechanical engineering is reflected in the third edition of this handbook, recently revised after six years. Growth in both practice and fundamental principles has necessitated numerous changes in the text, to which has been added a section on vibration. Standards and practice are brought up to date.

Physical data have been revised to incorporate best current values, and developments in special fields, such as welding, are discussed at greater length. The larger technical fields are subdivided into smaller sections, this being brought about by the increased development in differentiation and specialization. More than 70 specialists, each one prominent in his field, collaborated in compiling the text of this volume. Contributors have increased in number over previous editions.

□ □ □

Fundamentals of Mechanics

Applied Mechanics, by Frederic N. Weaver; cloth, 322 pages, 6 x 8½ inches; published by Ronald Press Co., New York, and supplied by MACHINE DESIGN for $3.25, plus 15 cents postage.

In this book the arrangement of material, while involving no radical departure from the conventional methods of presentation, is somewhat original. Center of gravity and moment of inertia are covered in the appendix, permitting an orderly and continuous development of mechanics, starting with statics and friction and continuing without a break through the subject of motion.

Also to preserve the continuity the various phases of harmonic motion are gathered under the heading of periodic motion and treated after the subject has been discussed in a broad sense. Both the illustrative problems and the problems in the text are practical and designed to illustrate theory. Graphical and analytical solutions usually are given in parallel to show that the same kind of reasoning applies no matter what type of solution.

The volume is written to serve as a textbook and in the preface the author states that a knowledge of elementary calculus has been assumed on the part of the student, but not a knowledge of physics. Basing the text upon his teaching and engineering experience, Prof. Weaver, has aimed to present adequately the fundamental principles of mechanics, and yet win the interest of the engineer by immediate application of theory to practical or semi-practical problems.

□ □ □

Mechanical Movements

Ingenious Mechanisms for Designers and Inventors, edited by Franklin D. Jones; cloth, 536 pages, 6 x 9 inches; published by Industrial Press, New York, and supplied by MACHINE DESIGN for $5, plus 15 cents postage.

Material collected over a period of 15 years has been worked together to form this interesting volume. The illustrated descriptions comprise a wide variety of standard and special mechanisms selected by experienced machine designers and inventors. Contributors number 110, the assistance of whom was obtained through prize competitions conducted by *Machinery.*

Mechanisms treated embody principles which can be applied to various classes of machines, and a study of such mechanical movements is particularly important to present-day design in which automaticity is playing an important part. This book supersedes the one entitled, "Mechanisms and Mechanical Movements." The important material from the latter work, however, has been retained in the new book.

□ □ □

Drawing Instruction

Machine Drawing, by Charles L. Griffin and Robert H. Fortman; cloth, 288 pages, 5½ x 8½ inches; published by American Technical Society, Chicago, and supplied by MACHINE DESIGN for $2.00, plus 15 cents postage.

Recognizing the importance of the draftsman in engineering work, this book has been conceived to serve as further instruction in drawing and layout. Outstanding among its features is the practical training it gives in detailing. Where new techniques or principles are presented, they are developed in a step by step method of presentation which is carried out in the drawings accompanying the discussion.

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

AWARD of the American Iron and Steel institute medal for the best paper presented in 1929 recently was made to Prof. H. F. Moore, University of Illinois. The paper was entitled, "Fatigue of Metals." Born in Penacook, N. H., in 1875, Professor Moore was graduated from the University of New Hampshire in 1898 with a B. S. degree, receiving an honorary D. Sc. degree in 1922. From 1901 to 1903 he was instructor in machine design at Cornell university. In 1915 he was appointed research professor of engineering materials at the University of Illinois, in which capacity he since has remained. Besides designing a number of large testing machines, Professor Moore is the author of "Textbook of the Materials of Engineering," which recently was published in its fourth edition.

RESEARCH work, principally in the study of intercrystalline failure in metal and of the nitriding process, is but one of the activities of Dr. Victor O. Homerberg. His appointment as technical director of the Nitralloy Corp., New York, recently was announced, bringing him into closer relation with the design of machines. In addition Dr. Homerberg is associate professor of physical metallurgy at Massachusetts Institute of Technology, his alma mater. Noteworthy is his work as author and co-author of articles pertaining to physical metallurgy and principles of metallography. He is chairman of the publications committee of the subcommittee on nitriding of the American Society for Steel Treating.

PIONEER in designing, building and operating portable X-ray testing apparatus, Dr. Ancel St. John has organized his own company in New York. His career in this work has been interesting, a penchant for X-ray study having developed while he was an instructor in physics at Syrian Protestant college, Beirut, Syria. From 1912 to 1917 he was instructor in physics, Worcester Polytechnic institute, and in 1918 Union Carbide & Carbon Corp., New York, employed him to take charge of X-ray research. It was during this affiliation that he developed the liquid absorber method now extensively used in making X-rays of castings and irregular metal products.

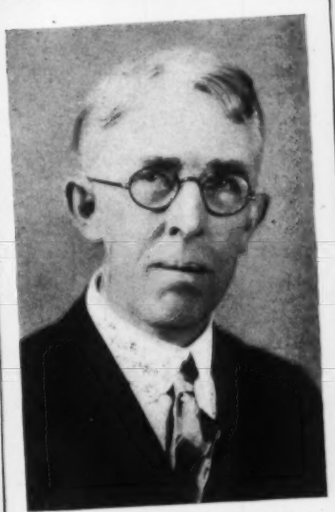
FOR his original research and development in welded aircraft construction, J. B. Johnson, chief of material branch, war department, Wright Field, Dayton, O., has been awarded the 1930 Morehead Medal of the International Acetylene association. The presentation was made at the thirty-first annual convention of the association at Chicago recently. Mr. Johnson was born in Olean, N. Y., May, 1890. After attending high school there he entered Cornell university, graduating in 1912 with a degree in mechanical engineering. His work has been in connection with railroad and airplane engineering and for the past 10 years he has been directing research and development of materials and processes for use in the construction of aircraft.

THE Samuel Wylie Miller medal of the American Welding society recently was presented to James W. Owens. It was bestowed upon him in honor of his work in connection with the application of welding to marine construction. Mr. Owens resigned recently as director of welding for Newport News Shipbuilding & Dry Dock Co. to become director of engineering for the Welding Engineering & Research Corp., New York. For the past 12 years he has devoted his entire time to the development of welding and cutting. He has a keen interest in the standardization of welding and cutting terminology and symbols and under his chairmanship the first report of the American Welding society's nomenclature, definitions and symbols committee recently was completed and issued.

IN RECOGNITION of his constructive contribution to the advancement of the manufacturing branch of the electrical industry, R. W. E. Moore has been awarded the 1930 manufacturers' medal and purse given under the James H. McGraw award. Mr. Moore is engineering manager of association activities of Westinghouse

Leaders in Design, Engineering and Research

DR. V. O. HOMERBERG



PROF. H. F. MOORE

DR. ANCEL ST. JOHN

J. B. JOHNSON

J. W. OWENS

R. W. E. MOORE

Electric & Mfg. Co. Entering the employ of the company in 1906 in the drafting department, he later became a member of the research department and was appointed assistant to manager in 1912. His present duties with the company were assumed in 1917. Attending first Phillips Academy, Andover, Mass., Mr. Moore continued his studies at Carnegie Institute of Technology.

* * *

Charles L. Lawrance has organized the Lawrance Engineering & Research Corp. Mr. Lawrance will be the president and dominating figure in the new enterprise. The new company is entirely independent of other aviation interests, and although it has no connection with Curtiss-Wright Corp., Mr. Lawrance is continuing as director and also as vice president of Curtiss-Wright Corp.

* * *

Lorenz Iverson, vice president, Mesta Machine Co., Pittsburgh, and West Homestead, Pa., has been elected president to succeed the late Harry F. Wahr. Mr. Iverson has been associated with the company for many years. Prior to his election as vice president in 1925 he had been chief engineer.

* * *

W. S. Johnston, associated for the past four years with Allied Engineers Inc., New York, recently accepted a position with Stone & Webster Engineering Corp., Boston, Mass., as engineer of the mechanical division.

* * *

W. F. Gerhardt, the first student to be graduated from the aeronautical engineering department of the University of Michigan, will take charge of the department of aeronautical engineering at Detroit City College.

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Dr. Harvey N. Davis, president of Stevens Institute of Technology, representing the American Society of Mechanical Engineers, has been appointed chairman of the education research committee organized at the recent meeting of the Engineering Foundation at New York.

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Ralph A. Vail, formerly vice president in charge of engineering of Durant Motors, and Roy E. Cole, chief engineer of the corporation, have formed the Vail-Cole Engineering Co., consultants, with headquarters in Detroit.

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George J. Mead, vice president in charge of engineering of the Pratt & Whitney Aircraft Co., Hartford, Conn., has been appointed head of the new experimental research division, United Aircraft & Transport Corp., the holding company for both the Pratt & Whitney company and Chance Vought Corp., subsidiaries. Mr. Mead also is chairman of the executive committee of the Engine Mfg. Co.

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Robert J. Broege recently was made vice president and general manager of the International Engineering Corp., Chicago. He previously was connected with the Buda Co., Harvey, Ill., of which he was chief engineer of the diesel engine division.

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W. H. Himes, a member of the mechanical engineering department, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., recently was promoted to manager of the engineering department. His appointment followed the resignation of L. F. Burnham.

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D. C. Jackson Jr. has resigned as head of the department of mechanical and electrical engineering, Speed Scientific school, University of Louisville, to take charge of the department of electrical engineering, University of Kansas at Lawrence, Kans.

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Earle S. Henningsen has been appointed engineer of the alternating current engineering department of the General Electric Co., Schenectady, N. Y., succeeding H. G. Reist, retired.

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Wade Doty recently was appointed chief engineer of the Two Way Shock Absorber Co., Jamestown, N. Y. He formerly was sales engineer of that company.

* * *

James M. Shoemaker has accepted the post of lecturer in mechanical engineering at the University of Southern California, Los Angeles.

* * *

Frank W. Lovett, who for 13 years has been identified with Link-Belt Co., Chicago, the last eight of which he has designed machinery for sewage treatment plants, has been appointed engineer in charge of sewage disposal equipment in the western territory. He will operate from the plant office in Chicago.

* * *

Willard H. Dow, formerly assistant general manager and a member of the board of directors, Dow Chemical Co., Midland, Mich., has

(*Concluded on Page* 72)

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

PAPERS presented at the fifty-first annual meeting of the American Society of Mechanical Engineers at New York, Dec. 1-5, covered a wide range of engineering subjects, many of which dealt directly with design. Typical of this was the discussion of the design of the new Harris automatic two-color flat-bed press, by A. S. Harris, Harris-Seybold-Potter Co., Cleveland. Salient features of this paper covered rigidity of the frame, impressional strength, uniformity of bed travel during printing stroke, evenness of ink distribution and accuracy of register.

Another of the papers on printing presses brought to light some problems in standardization. Fred S. English prepared it with a view toward showing the vital need for more standardization in the printing industry. "Plastic Torsion" was the title of a contribution by Dr. Ing. A. Nadai. So far it has not been possible to compute the distribution of the stresses in twisted bars of other than circular cross section if the bar is stressed above the plastic limit and the effect of work hardening is considered, Dr. Nadai asserted. There exists, however, a case in which it is possible to determine the distribution of stresses in twisted bars other than circular cross section after the yield point has been reached.

A relatively simple method of calculating the natural frequencies of torsional vibration was set forth by Frederic P. Porter in his investigation offered at the meeting. This simplification is obtained by the proper choice of the equivalent system for mathematical treatment and by the use of tables and charts. The first part of the problem from a design standpoint is the calculation of natural frequencies of torsional vibration for the shaft arrangements.

Formulas for calculating stresses existing in press shrink fits were presented by J. W. Baugher Jr. Elimination of keys, keyways and keyseats reduces manufacturing costs, removes the danger of failures from concentrated stresses and permits the use of smaller shafts than would be possible if they were keyseated. Stresses in retaining and centering rings for turbine generator rotors were discussed by R. Patterson and D. H. Harms. Tremendous centrifugal forces necessitate high working stresses, they declared, and in order to be assured of adequate factors of safety for known materials, stress distribution must be known more accurately than ever.

In the field of materials one paper covered comparative physical properties of chromium nickel, chromium manganese and manganese steels, and another discussed the properties of nonferrous alloys at elevated temperatures. Lubrication was treated in several papers, one of which set up the work factor for lubricating oil and outlined a new method of evaluating lubricants.

* * *

1930 To Be Peak Year for Patent Office

INCREASE in the receipts of applications for patents covering radio, talking picture equipment and refrigerators indicates that 1930 will be the biggest year in the history of the patent office, according to Commissioner Thomas E. Robertson. So numerous have become the radio patent applications that one entire division and portions of two other divisions of the patent office have been assigned to this work.

Total applications received in 1929, the previous peak year, were 75,402, while in the first ten months this year the applications received number 75,868, with two months still to go. At present there are pending something like 112,-838 applications before the patent office awaiting action.

* * *

Fund To Meet Unemployment Emergency

UNEMPLOYMENT effects are being combatted by a fund to which every employe of the General Electric Co., from president to office boy, is contributing one per cent of his December wage. The company will match each contribution dollar for dollar, President Gerard Swope has announced.

Under the rules of the unemployment plan, as originally announced, payments were not to be made for at least six months after its inauguration, which would not be until January or February. Because of the unemployment emergency, however, it was decided to start relief this month, but limit payments to a maximum of $15 per week to employes needing assistance. It also has been decided to consider for assistance employes who may not have

contributed to the plan but who are in need of assistance. Approximately 35,000 employes have been contributing to the plan and on December 1 they had paid in $350,000.

* * *

Inventors Are Aided by Cleveland Body

THROUGH a service recently established by the industrial development department of the chamber of commerce, Cleveland, inventors may submit descriptions of their devices. These then are listed in a letter which is sent to more than 2000 manufacturers. The man with an idea only also is encouraged although it is suggested that he protect himself if patents not yet have been applied for.

Several hundred people already have taken advantage of the plan and a number now are negotiating with manufacturers. Those interested in this patent and idea service are urged to submit full details with the first letter. Communications should be sent to Industrial Development department, Chamber of Commerce, 1704 Terminal Tower, Cleveland.

* * *

Auto Design Follows American Trends

AMERICAN influence in French automotive design was revealed at the opening of the 1930 auto salon in the Grand Palais, Paris. Quiet running through such features as four silent speeds, silent third and fourth speeds, is emphasized.

The main effort, however, has been put on the motors themselves. Old French technique of developing high power through the use of very small high-speed engines that turned over about twice as fast as the average American motor has lost favor. The American style of a big engine, running at a more moderate speed, with lower gearing and greater pickup, is gaining popularity. French engineers agree that the American type is quieter, vibrates less, uses itself up less rapidly and lubricates better.

* * *

Inventor's Achievements Commemorated

MEMORIALIZING the life and scientific achievements of the late Dr. Elmer A. Sperry, inventor of the gyro-compass and more than 350 other significant inventions in virtually every major field of science and industry, a special exhibit was opened recently for one month's showing at the Museums of the Peaceful Arts, New York City's museum of science and industry, 220 East Forty-second street.

The exhibit, held in conjunction with the fifty-first annual meeting of the American Society of Mechanical Engineers held recently is one of the first attempts ever made to portray in a single exhibit the services and achievements of distinguished American inventor. It includes complete operating gyro-pilot equipment, a sixty-inch aircraft searchlight, photographs, models, and actual apparatus to portray Dr. Sperry's early experiments with water wheels, hydraulic turbines, the dynamo, the electric arc, and on through the period of his invention of storage batteries, electric locomotives, electric automobiles, electric trolleys, diesel engines, "rail-detector," various mining mechanisms and metallurgical devices, submarine alarm, gun-fire control devices and others of the outstanding Sperry inventions. In addition there are shown the various honors which he received during his 48 active years as an inventor, consisting of diplomas, medals and other honors awarded to him by his own and foreign countries as well as by various engineering and scientific societies.

* * *

Proposed Standard Is Published in Full

A DRAFT of the proposed American tentative standard for abbreviations for scientific and engineering terms (Z10i) has been published in full for the purpose of obtaining widespread comment and criticism. This draft was prepared by the American Standards association technical committee on scientific and engineering symbols and abbreviations under the chairmanship of J. Franklin Meyer of the United States bureau of standards.

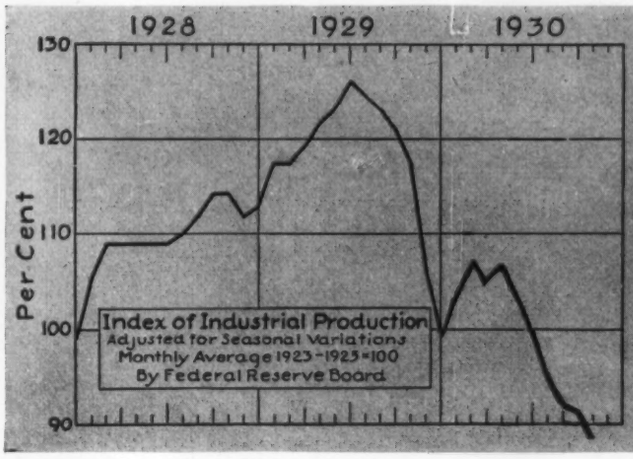
Comment on or criticism of the draft may be addressed to the American Standards association office or directly to Preston S. Millar, secretary of the technical committee, Eightieth street and East End avenue, New York.

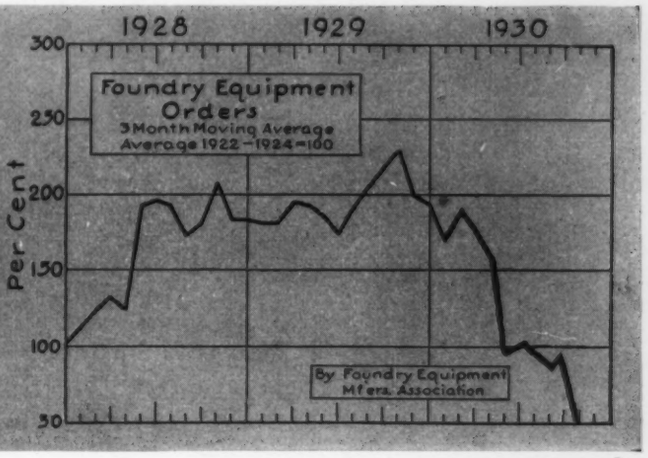
* * *

Art Incorporated in Design of Machinery

EMPLOYMENT of art rapidly is finding a place in the design of machinery. Plans were formulated recently by the Westinghouse Electric & Mfg. Co. for incorporating fine appearance as well as mechanical perfection in the design of electrical machinery. Until recently the utilitarian point of view was the major factor in design of larger units of electrical equipment. In the future, however, Donald R. Dohner, former instructor in design, Carnegie Institute of Technology, will act as art director and supervise the new plans from this aspect.

Under his direction a course is being offered to the company's designers and engineers with a view toward imbuing the engineering departments with a conception of art in its relation to industry. This will be a part of the regular graduate student course offered by the company to the engineering students. For the older men a similar course is given at Carnegie Institute of Technology.



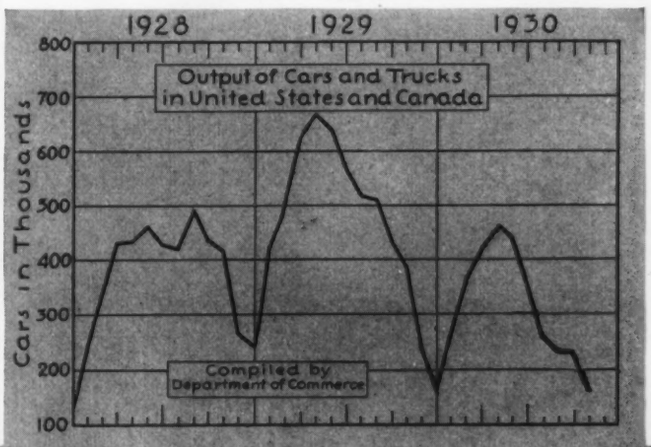


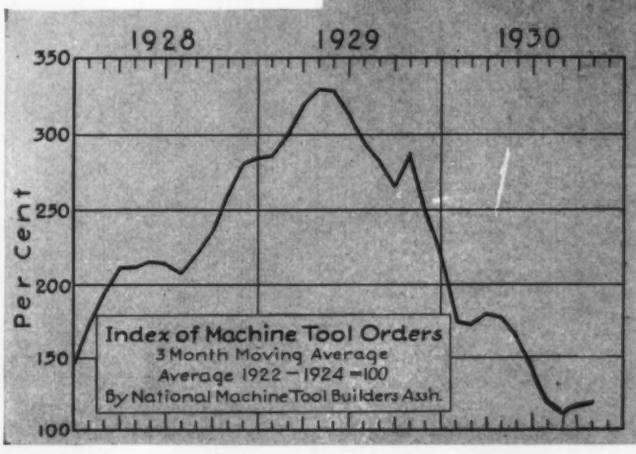
How Is Business?

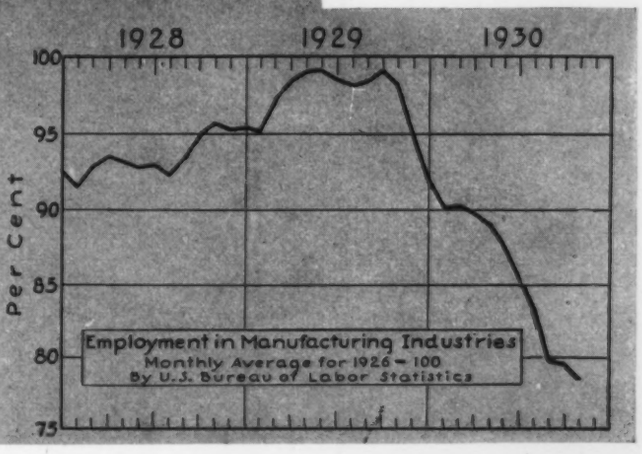
SEASONAL slackening in industrial activity augments the general business depression and leaves the closing month of 1930 cloaked in a haze of uncertainty as the new year approaches. Many of the leading economists predict a slow but certain recovery with the beginning of 1931, when deferred buying power is expected to come back into the market.

It has been said that pessimism of the prevailing sort nearly always augurs well and immediately precedes an upturn. To forestall a hard winter of unemployment, governmental and industrial agencies have recruited measures which promise to aid conditions. Engineering activities as a rule have been maintained and manufacturers continue to feel the need for refinements in the design of their products. The fact remains, however, that general conditions must improve and boost production to create an immediate market for more advanced equipment. Inventories now hold the center of interest in business organizations.

To look back over 1930 and its black business history is disheartening. Industrial machinery exports during September fell to $15,450,000 as against $21,151,000 a year ago. Industrial activity in the basic industries continues to decline moderately. In the automotive field, however, a few builders are engaged in introducing new models, an assisting factor which was sufficient to boost November's production above that of October. Some activity along small machine tool lines prevails.







NEW MATERIALS AND PARTS

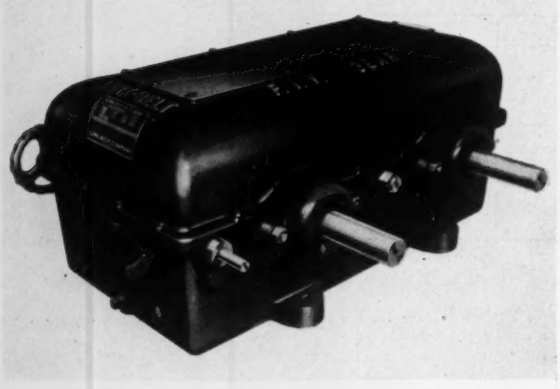
Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

Unit Has Wide Range of Speeds

VARIABLE speed transmissions available on the market now include the ingeniously designed P. I. V. gear, which recently was announced by Philadelphia branch of the Link-Belt Co. The initials of this new unit stand for "positive infinitely variable," indicating its characteristics. Complete design details of the operating mechanism are given on page 24 of this issue of MACHINE DESIGN.

Five sizes ranking in capacity from 1 to 10 horsepower and providing speed change ratios up to a maximum of 6 to 1, have been put into production. Tests have been made throughout the past year by continuous operation of the unit on machine tools, textile equipment, baking, glass and paper making machinery. In these services it has proved successful and because of its compactness and wide range of speed variation, it has made possible desirable improvements in the design of several types of machines.

Basically, the drive consists of two pairs of wheels of the opposed conical disk type, between which a unique chain transmits power. The effective diameters of each pair of wheels can be altered under load to change the speed ratio, without steps or without dependence upon friction. On changing speed, the chain rises in one set of wheels and descends in the other. A speed indicator permits ready check-up on operating speed settings. An exterior view of the unit is shown in the accompanying illustration.

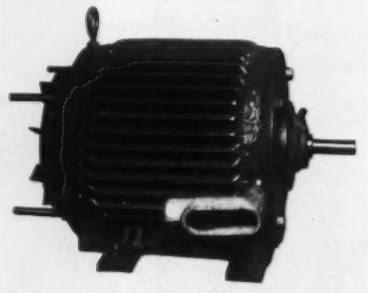


All parts of variable speed transmission are fully enclosed and self lubricated

The wholly original feature of the new unit is its use of a positive chain drive to transmit the power. Radial teeth are cut in the conical faces of the driving disks, and the teeth projecting beyond the sides of the chain are arranged to engage the radial teeth of the disks.

Enclosed Motor Is Fan Cooled

NUMEROUS new and unusual design features characterize the totally enclosed, fan cooled induction motor recently announced by Lincoln Electric Co., Cleveland. This new motor, shown in the accompanying illustrations, is designed to include arc welded steel construction, double sealed ball bearings, and a removable cover.



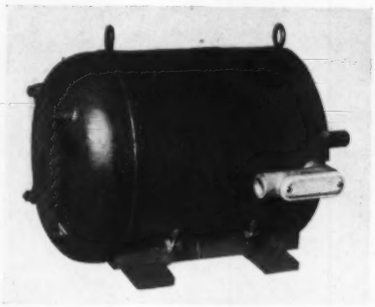
Totally enclosed fan-cooled motor with cover removed to show corrugated radiating surface

An unusually large radiating surface is obtained by complete enclosure of sides of the motor with a deeply corrugated sheet of corrosion-resisting metal. This conducts the heat created within the motor to its outer radiating surface which is cooled constantly by a continual draft of fresh air. The air imprisoned within the completely sealed frame is circulated by a fan arc welded to the rotor. This fan drives the heated air within the motor to continuous contact with the large corrugated cooling surface. Outside air which drives the heat from the radiating surface is forced over the exterior of the corrugated surface by a large arc-welded fan attached to the motor shaft.

The corrugated cooling surface is easily accessible for cleaning as the one-piece cover can be removed by loosening the two thumbscrews which hold it securely in place. Stator lami-

nations are stacked in the frame by hand, then subjected to extremely high pressure. While under pressure they are permanently affixed by a retainer ring which is arc welded to the frame, making the stator core an integral part of the motor frame.

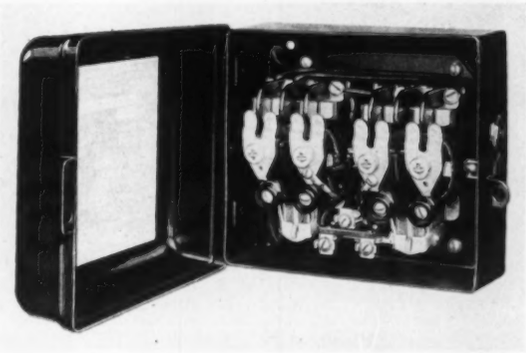
To insure complete enclosure of the motor the rolled steel end plates are machined to accurately fit the end rings of the motor frame. The ball bearings which enclose the shaft opening in the end plates are sealed both inside and outside. This new "Linc-Weld" motor has the same mounting dimensions as standard, open type, horizontal motors of equal rating. It is manufactured in sizes from 1 to 50 horsepower.



Rolled steel end plates are machined to accurately fit the end rings of the motor frame

Contactor Is Made in Two Types

DESIGN of a new small motor reversing contactor, Class 8711, has been announced by the Industrial Controller division of the Square D Co., Milwaukee. Manufactured in two types, one for two-wire control only and one for two and three-wire control, the starter is used primarily for operating control on small machine tools and for window opening and closing apparatus. The unit may be wired for controlling single phase, three or four-wire reversible motors or three phase motors.



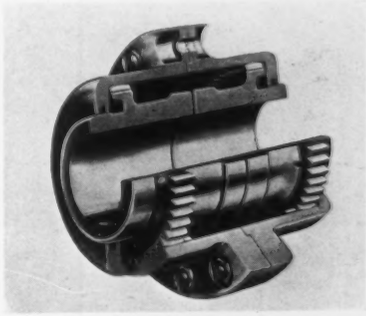
Interior view of small motor reversing contactor manufactured in two types and mounted in sheet metal case

The two double pole double break contactors of which the starter consists, are mechanically interlocked and mounted side by side on a sheet metal panel in a sheet steel case. Contacts both movable and stationary are of silver, and the armatures are of the full floating type. Wiring terminals are conveniently located at the top. Enclosing case is 8½ x 6½ x 4¼ inches.

Flexible Coupling Is Geared Type

MEDIUM duty type flexible coupling in a new model recently was announced by Poole Engineering & Machine Co., Baltimore, Md. Construction is of the geared type, having no flexing materials. Both sleeves and hubs are machined from solid bars of high-grade high carbon steel. Sleeve members and end plates are integral and clearance space between end wall of sleeve and hub allows free end float to each shaft.

The coupling adjusts itself to all conditions, leaving its members free to float without causing strain to bearings, shafts or any other parts. It is fully lubricated, oil tight, dust and moisture proof. The medium duty type has been designed to be adapted to drives such as pumps, fans, small compressors, small generators, blowers, conveyors, elevators and other types of light or medium duty machinery.



Flexible coupling of medium duty type is fully lubricated, and allows free end float to each shaft

New Bearing Grease Announced

NEW GREASE for ball and roller bearing motors has been announced by General Electric Co., Schenectady, N. Y. It embodies all necessary qualities for the proper lubrication of ball and roller bearings and is used in the company's factories for the initial lubrication of all general purpose motors using these types of bearings. This lubricant is being used successfully on ball bearing units with speed as high as 25,000 revolutions per minute and temperature exposures from —25 degrees to 250 degrees Fahr. However, its use is recommended only for the lubrication of motor bearings where the motors were orginally grease lubricated.

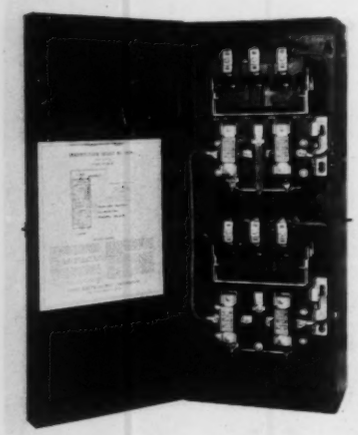
High grade materials are selected for its com-

pounding and it maintains an operating consistency under severe conditions and over as wide a temperature range as will be encountered in service. It has unusual film strength, enabling it to stand severe thrusts and heavy bearing loads. The new lubricant is supplied in two-ounce tubes and one-pound cans. A tabulation appearing on the instruction sheet accompanying the two-ounce tube denotes the amount of grease used in the various motors by frame sizes.

New Starters Prevent Arcing

CONTROL and protection of squirrel cage induction motors are features of the new reversing across-the-line air motor starter recently announced by Condit Electrical Mfg. Co., Boston. The unit, known as type A-30-R, consists of two of the type A-30 arc prevention motor starters mounted in a sturdy enclosing case and mechanically interlocked so that only one starter can be in closed position at one time.

Both starters are equipped with thermal relays for time lag overload protection. The



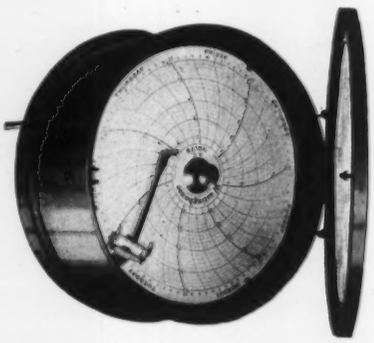
Interior view of reversing across-the-line motor starter which employs thermal relays for time lag overload protection

type A-30-R starters are furnished for push button control up to 20 horsepower, 550 and 440 volts; 15 horsepower, 220 volts, and 7½ horsepower, 110 volts.

Introduces New Recording Unit

A NEW circular chart recording instrument, identified as type A, has been announced by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. These instruments which include ammeters and voltmeters, have numerous applications in industry. They may be employed to determine the most economical use of motor-driven machinery, the loading of motors, time of starting in mornings or after lunch hour, time of quitting, loss of time, and power required for different operations or depth of cuts.

Although designed principally for alternating current applications, they also are applicable to certain direct current services. Ammeters are available in sizes ranging from 5 to 50 amperes, and give a full-scale reading from zero to the value at which the meter is rated. Voltmeters are made in ratings varying from that which provides a scale of from 90 to 140 volts



Circular chart recording instrument is designed principally for alternating current but may be used for certain direct current services

to that which records a maximum of 550 volts.

Three kinds of clocks for moving the circular chart are provided: a key-wound, 8-day clock for driving the one-week charts; a key-wound, 36-hour clock for driving the one-day charts; and a sub-synchronous (self starting) motor-driven clock, operated by the system frequency. Change gears are available to change synchronous-driven meters to other speeds.

Starters Employ Thermal Relays

INCLOSED automatic motor starters for two-speed separate winding type squirrel cage motors recently announced by Cutler-Hammer Inc., Milwaukee. These starters, known as Bulletin 9736, are the across-the-line type, the windings being connected directly to the line. Both windings are protected against dangerous overloads by means of thermal overload relays. A pushbutton master switch with "stop," "low" and "high" buttons is used to obtain control from a remote point.

Starters can be furnished in three types; for starting on either winding, with sequence compelling feature or with automatic sequence control relay. For starting on either winding, depressing either the "low" or "high" button starts the motor on the respective "low" or "high" speed winding. The sequence compelling feature requires that the motor always be started at low speed before transferring to high speed.

Depressing the "high" button will not start the motor. The automatic sequence control relay insures that the motor will always start at low speed and pass to high speed automatically if the "high" button is depressed. On all three

BRANDED SHAFTING

Like the artist's name on a great painting—the name that establishes its identity as the product of a master craftsman's creative skill and genius—the name that eventually dictates its acceptance in the world of art—the symbol shown here permanently is imprinted on each end of each Columbia Steel Bar. No longer is the identity of Steel Shafting a matter of uncertainty. ¶ No longer is there need to buy Shafting without knowing exactly the maker responsible for it. ¶ For every imaginable use in your product or plant, BRANDED SHAFTING—COLUMBIA SHAFTING — now is available. Columbia Steel & Shafting Co., Pittsburgh, Pa.

COLUMBIA

COLD FINISHED BARS AND SHAFTING

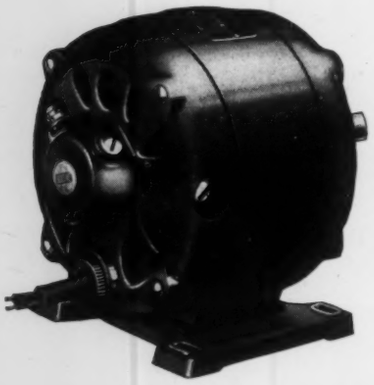
types, if the motor is operating at one speed it can be transferred to the other speed by simply depressing the other speed button, it is not necessary to stop the motor.

Motor Embodies New Features

DESIGN of the new type N-5 fractional horsepower motor, which ultimately will replace the older Bodine SA and SD motors, recently was announced by Bodine Electric Co., Chicago. It embodies new features which include a frame equipped with specially developed wool-packed bearings. Two frame sizes now are in production, having the following ratings: 1/20 and 1/12 horsepower at 1125 revolutions per minute, 1/10 and 1/8 at 1725 revolutions per minute.

Double oil slots at the sides of the bearing provide double contact areas for the wool packing on the motor shaft. Adequate lubrication without flooding of the bearing is obtained. A high grade knitting yarn is packed around the nonfreeze leaded bronze bearing, and a tight dust cap makes it totally enclosed. Grit and dust are excluded.

Large ventilating ducts on the stator permit



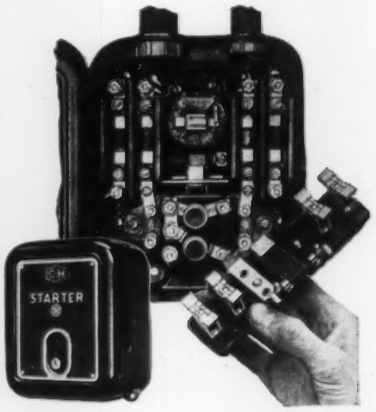
Fractional horsepower motor has specially developed wool packed bearings and large ventilating ducts on the stator

the use of a larger fan. The ventilation in the type N-5 is consequently superior to that of the SA and SD frames. Increase in ratings for a given frame size ranges from 15 to 30 per cent.

Automatic Starters Are Redesigned

REDESIGN of its entire line of type AAA automatic starters for small alternating current motors to incorporate a newly developed "twin break" magnetic contactor has been announced by Cutler-Hammer Inc., Milwaukee. This new device provides many features which are of interest. Contacts are of heavy coin-silver which retains its current carrying capacity even if oxidized. The "twin break" principle reduces the arc voltage by half, and thermoplax arc pockets, by reducing the air content around the contacts, actually prevent the formation of a destructive arc. The arc pockets also act as a shield so that wires which are run along the side of the contactor cannot interfere with its operation.

A magnetic latch has been added to prevent accidental closure of the contacts if the starter is accidentally bumped or tilted. The latch must be drawn aside by the operating magnet before the contacts can close. This is an im-



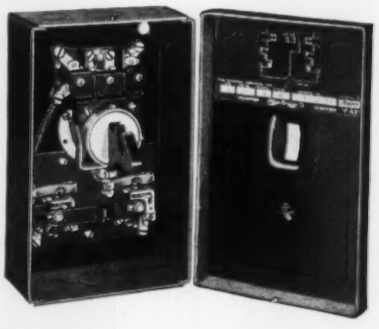
Across-the-line type starter equipped with new twin break magnetic contactor. Board is removed to show silver butt-type contacts

portant feature, particularly if the starter is mounted on moving machinery. A new hinge structure facilitates removing and replacing the contact board and insures correct replacing of the board before the starter can operate.

These new contactors are made in 3 and 4-pole types. The maximum rating for 2 or 3-phase are: 3 horsepower, 110 volts; 5 horsepower, 220 volts, and 7½ horsepower, 440 or 550 volts. The illustration shows the bulletin 9586 across-the-line type starter equipped with this new contactor. Contact board is removed to show the silver, butt type contacts.

Breakers Use Safety Interlock

OVERLOAD breakers operating on the soldered ratchet principle eliminate the maintenance of thermal plugs and fuses on the new hand-operated alternating current starting



Overload circuit breaker is adaptable to many types of installations because of simplicity of construction

switch recently announced by Allen-Bradley Co., Milwaukee. This new bulletin 609 starter handles all motors up to 3 horsepower, 110

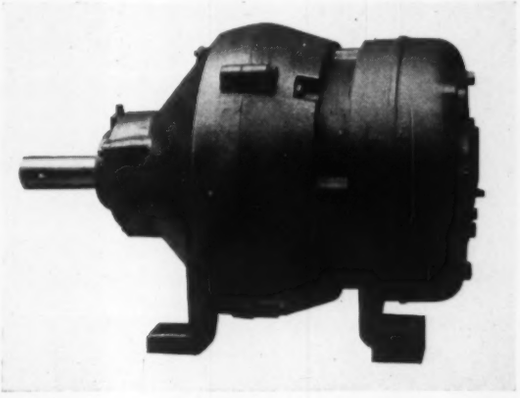
volts; 5 horsepower, 220 volts; 7½ horsepower, 440-550 volts.

Any overload will be interrupted by the breakers which are reset with a lever without opening the switch cover. The starting lever has a safety interlock, preventing the cover from being removed unless the lever is on "off" position. The switch can be padlocked in open position if required. Its simplicity of construction makes it available for many types of installations.

Speed Reducers Are Motorized

MOTORIZED speed reducers in ratings from 1/6 to 20 horsepower and in speeds from 50 to 406 revolutions per minute recently were announced by Production Equipment Co., Cleveland. The unit is a combination of a standard motor with a planetary reduction built in one bearing bracket. This bracket is modified to suitably mount the planetary reduction, but the general appearance and the overall dimensions differ but little from those of the standard motor.

Ball bearings are used throughout and the planetary gears operate in oil. The slow speed



Motorized speed reducer capable of developing from 7½ to 10 horsepower

shaft extension is located in the same position as the shaft extension on a standard motor and can be coupled directly to the driven equipment. For belt chain or gear drive the use of an outboard bearing ordinarily is recommended. Motorized speed reducers are available in single speed, multispeed, enclosed and high torque designs for either horizontal or vertical mounting.

Develops New Line of Motors

INTRODUCTION of a new line of single-phase repulsion induction motors, designated type SCA and capable of frequent reversal has been announced by General Electric Co., Schenectady,

RARE METALS AND ALLOYS

FANSTEEL

best source of supply for

Contact Points

Plenty of Reasons

—and any one of them is reason enough » » »

1 Indicative of their superiority since 1914, more Fansteel Contact Points have been used than any other kind—almost 50 tons a year!

2 Fansteel refines Tungsten from basic materials to 99.95% purity—all in one plant, under one responsibility.

3 Fansteel originated "end grain" metal contact points—sawing them from rods instead of stamping from sheets. Presents better wearing surface, eliminates flaking. All high grade contact points are made in this manner, under Fansteel patents.

4 Fansteel keeps close laboratory control over every step in every refining and manufacturing process.

5 Fansteel inspects every individual contact point at least 4 times.

6 Fansteel engineers will work with and for you, even designing contact points specially for your product, if necessary, and giving them thorough breakdown tests.

7 Wide range of standard types covering any ordinary requirement carried in stock for immediate delivery.

Any one of the above facts is in itself a good reason why you should investigate Fansteel Contact Points for your product. Why not write today?

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FANSTEEL PRODUCTS COMPANY, Inc.

NORTH CHICAGO, ILLINOIS

MACHINES

of all types are designed by executives and engineers who read Machine Design.

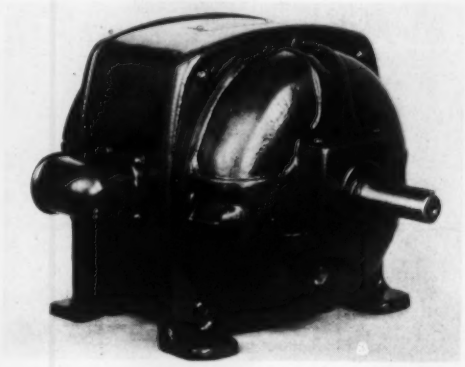
According to the U. S. Bureau of Census classifications, these types are:

*Adding machines
*Addressing and mailing machines
*Agricultural machinery
*Aircraft
*Bakers' machinery
*Baling presses
*Blowers and fans
*Bookbinding machinery
*Bottling machinery
*Calculating machines
*Canning machinery
*Card-punching and tabulating machines
*Cars and trucks
*Cash registers
*Cement and concrete machinery
*Change making machines
*Check writing machines
*Clay working machinery
*Clothes pressing machines
*Coffee roasting and grinding machines
*Condensers
*Confectionery and ice cream machinery
*Conveying machinery
*Cotton gins
*Cranes, including hoists and derricks
*Dairy machinery
*Dish washing machinery
*Dredging and excavating machinery
*Electrical machinery
*Elevators and elevator machinery
*Engines, steam and internal combustion
*Fare registers and boxes
*Flour mill and grain mill machinery
*Foundry machinery
*Gas machines
*Gas regulators
*Glass making machinery
*Hat-making machinery
*Hydraulic machinery
*Incandescent lamp making machinery
*Laundry machinery
*Lawn mowers
*Leather working machinery
*Locomotives
*Machine tools
*Manifolding machines
*Metal working machinery
*Meters, gas and water
*Mining machinery
*Miscellaneous and special machinery
*Motion picture cameras and projectors
Motorcycles and bicycles
*Motor vehicles
*Oil-mill machinery
*Oil-well machinery
*Ore crushers
*Packaging machines
*Packing house machinery
*Paint making machinery
*Paper box machinery
*Paper mill and pulp mill machinery
*Pharmaceutical machinery
*Photo-engraving machinery
*Pneumatic machinery
*Printing machinery
*Pumps and pumping machinery
*Refrigerating and ice making machinery
*Road making machinery
*Rolling mill machinery
*Rubber working machinery
*Scales and balances
*Sewing machines
*Shoe machinery
*Slicing machines
*Slot vending machines
*Stokers, mechanical
*Stone working machinery
*Sugar mill machinery
*Textile machinery
*Tobacco manufacturing machinery
*Transmission machinery
*Typewriters
*Vacuum cleaners
*Washing machines, ironing machines
*Welding machines
*Well-drilling machinery
Windmills and towers
*Woodworking machinery

**Indicate classes of machines designed by Machine Design subscribers.*

N. Y. These motors have the same appearance as type SCR general-purpose single-phase motors, and are mechanically interchangeable in all respects with corresponding horsepower and speed ratings of that type.

Available ratings range from ¾ to 5 horsepower at 1800 revolutions per minute, and from ½ to 2 horsepower at 1200 revolutions per minute. All mechanical modifications which may be applied to the general-purpose SCR motors are equally applicable to the new type SCA. The starting torque is high and ranges from 225 to



Single-phase repulsion induction motor has high starting torque

275 per cent of normal full-load running torque depending on the rating.

The control for the new motor is simple, consisting only of a full-voltage 3-pole reversing switch which may be either manual or magnetic. Machine tools, garage equipment and door openers represent a small section of the actual field of application.

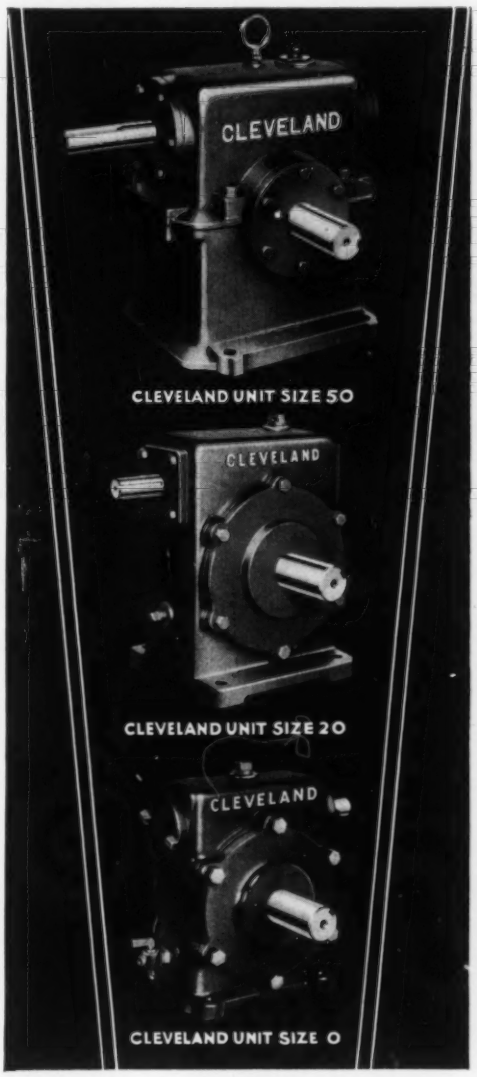
Aluminum Wire Is Insulated

ECONOMIC features of aluminum will cover a much broader field with the development of a variety of new insulated wires and cables recently announced by General Cable Corp., New York. Heretofore, practically all of the aluminum used in transmission of electrical energy has been in the form of bare conductors.

The initial group of insulated aluminum conductors includes such constructions as network cable, non-metallic underground cable, insulated line wire, armored cables, magnet wire, starter cable, and car wiring cable.

A company manufacturing textile machinery has a position for a man of inventive capabilities. One who can develop and put his ideas into workable form required. Give full information in reply.
Address P. O. Box 1513, Providence, R. I.

News— FOR EVERY SPEED REDUCER BUYER



These are the Cleveland Units now ready for shipment from stock at revised prices.

CLEVELAND ANNOUNCES A NEW IMMEDIATE DELIVERY PLAN ON SMALL REDUCERS

YEAR after year the demand for those Cleveland Units made in sizes up to four horsepower has steadily increased. Now this demand permits the manufacture of three small Cleveland Units on a **PRODUCTION** basis. Naturally, many resulting economies are effected and these savings are being **PASSED ON TO CLEVELAND USERS** in revised prices on small Clevelands.

In addition, a production schedule enables us to keep all the standard ratios of small Cleveland Units in stock, ready for **IMMEDIATE DELIVERY.**

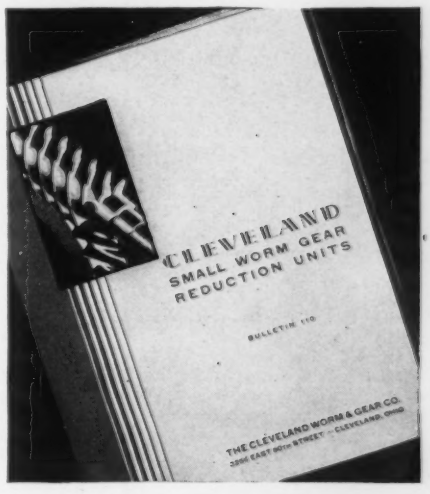
CLEVELAND QUALITY . . . CLEVELAND WORKMANSHIP . . . CLEVELAND DEPENDABILITY

No changes in specifications in small Clevelands have been made. You will find the same high quality materials—the same accurate workmanship—the same dependability and efficiency that has characterized all Cleveland Reducers in the smaller sizes.

SEND FOR THIS NEW BULLETIN

Complete details of sizes, ratios, horsepower ratings and prices of the three small Cleveland Units are given in Bulletin 110, just delivered from the printers. Every designer, every power plant engineer, every machine shop superintendent should have a copy of this bulletin—you may not need it now, but you may find it valuable any day.

Mail the coupon and a copy will be sent to you without obligation.



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CLEVELAND WORM GEARING—THE ULTIMATE DRIVE

THE CLEVELAND WORM & GEAR COMPANY
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Please send a copy of Bulletin 110.
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Penton's
Machine Shop Directory

ANYONE selling machinery, equipment or supplies to the leading manufacturers of the United States and Canada should use Penton's Machine Shop Directory. It is an invaluable ally to the advertising, sales and sales promotion departments as well as to the individual salesman. The directory will aid any company selling the machine shop field to amplify and correct its customer and prospect lists. Personalization of direct mail is made possible.

DATA is arranged alphabetically with a geographical cross index to facilitate use by sales territories, states or cities. The book contains names, addresses, principal products, personnel and other data on more than 5500 of the major companies operating manufacturing, contract or maintenance machine shops.

The price is $25.00, including postage, or less than one-half cent per company name.

Address your order to the

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238-S.-M.D.

Mounting Heavy Duty Antifriction Bearings

(Concluded from Page 38)

plate. The greatest variation is in the construction of the closure. Naturally, in any application of this sort there is a tendency for dust, dirt, chips, etc., to sift down the shaft and, if not stopped, into the bearing housing. The closure therefore consists of a labyrinth formed by a groove in the upper half of the adaptor, in which fits an annular rib on the upper dust deflector. The labyrinth is backed up by a deflector or baffle plate, bolted to the outer bearing closure, and helping to locate the felt ring which is provided in the bearing closure itself. The ring can be tightened to compensate for wear by screwing down the baffle plate. All this may seem unduly complicated, but it usually is more than justified by working conditions.

The list of examples is by no means exhausted by those that have been given; it could be continued indefinitely. But in the long run it will be found that nearly all heavy duty applications fall into well definied classes, and that each class has many points in common. What has been attempted is to point out how design can be made to fit these general requirements, by classes, rather than by individual cases. Most of the arrangements easily can be modified to meet special cases.

It is hoped that the applications outlined in the foregoing will serve to give at least a working idea of how the more important problems connected with the application of tapered roller bearings to heavy duty equipment can be solved to the best advantage.

Engineers Celebrate Anniversary

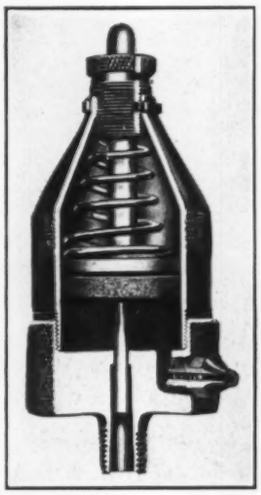
CELEBRATION of the fiftieth anniversary of the Engineers Society of Western Pennsylvania was held Nov. 14 at Pittsburgh. About 500 members and guests attended the anniversary banquet. Addresses covering the principal branches of engineering and their relation to the growth of the city were features. Each engineer present attending the banquet was given a complimentary book, prepared in comemoration of the event. It contained 400 pages and comprised data pertaining to work of engineers.

Latest developments in the application of welding as applied to manufacturing operations were discussed at the sixth annual conference on welding held at Purdue university recently, under auspices of the engineering extension department.

The MODERN DESIGNER DEMANDS A MODERN LUBRICATION SYSTEM . . .

to meet 3 essential requirements . . . .

. . . 1 POSITIVE LUBRICATION
2 SIMPLICITY
3 SALES ADVANTAGE



For the bearing which requires a constant flow of lubricant, use Alemite Automatic Cups, (adjustable).

Speed, accuracy and economy are demanded of the Production Man today.

Factories, to meet competition, must operate at peak efficiency.

Lubrication plays a dominant and vital part.

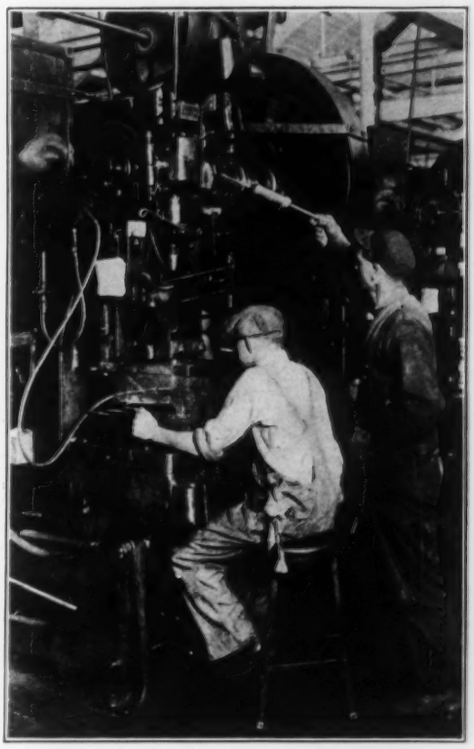
Consequently, haphazard and old fashioned methods have been replaced by modern and positive methods. Designers of modern machinery, therefore, look to the **ALEMITE HIGH PRESSURE LUBRICATING SYSTEM.**

The Alemite System is today standard equipment with 1200 makers and designers of modern machinery.

It is a positive system of lubrication. Lubricant is forced to the vital points of lubrication under 3000 pounds of pressure. It is a simple system. One needs only place the Alemite gun to the Alemite fitting, and a wrist action forces the lubricant under 3000 pounds of pressure to the vital points of lubrication.

ALEMITE

High Pressure Lubrication



Each bearing receives its systematic shot of lubricant, without the interruption of production, when Alemite is installed.

Inaccessible and "hard to reach" bearings are brought out to the open by means of Alemite Header Blocks. Their simplicity makes lubrication a quick and rapid job, and hence saves time and money. Such simplicity makes lubrication a safe job.

All these advantages, when the Alemite Systems are installed on your machines, add to the salability of your machines.

Send for the Alemite plan of conducting a lubrication test under your own supervision. Everything is furnished you, including cost sheets. Really expert and helpful consultation is offered you entirely without obligation.

Alemite Corporation (Division of Stewart-Warner), 2644 N. Crawford Ave., Chicago.

ALEMITE CORPORATION
(Division of Stewart-Warner)
2644 N. Crawford Av., Chicago, Ill.

We want to conduct a lubrication test under actual operating conditions. Send us all information for conducting such a test.

*Firm Name*_____

*Address*_____

*Your Name*_____

*City*_____ *State*_____

214

MEN OF MACHINES

(*Concluded from Page* 58)

been appointed president and general manager to succeed the late Dr. Herbert H. Dow. Mr. Dow was graduated from the University of Michigan in 1919.

* * *

W. L. Batt, president of S K F Industries Inc., New York, recently was elected a member of the council of the American Society of Mechanical Engineers to serve for three years.

* * *

Maurice L. Kerr recently was appointed chief engineer of the Brockway Motor Truck Corp., Cortland, N. Y. Formerly he was chief engineer of the Indiana Truck Corp., Marion, Ind.

* * *

John A. Binder recently joined the Continental Motors Corp., Detroit, as an experimental engineer. He formerly was in charge of the experimental laboratory of Durant Motors Inc.

* * *

Brinton Welser, secretary of the Chain Belt Co., Milwaukee, has been elected vice president and director of the company. Mr. Welser has been with the company since 1913 and is widely acquainted throughout the industry. He will continue his activities in engineering and sales work.

* * *

R. C. Pierce recently was elected vice president in charge of engineering and research of the General American Tank Car Corp., Chicago.

* * *

Capt. Anton Heinen, German dirigible designer, is reported to be constructing small dirigibles for private use, in a plant at Cape May, N. J.

* * *

Dr. D. J. McAdam Jr., naval engineering experiment station, Annapolis, Md., has been appointed chief of the section on metallography, bureau of standards, Washington.

* * *

E. S. Marks, chief engineer, H. H. Franklin Mfg. Co., Syracuse, N. Y., has been nominated vice president of the Society of Automotive Engineers, representing passenger car engineering.

* * *

John Howe Hall has been appointed technical assistant to the president of the Taylor-Wharton Iron & Steel Co., High Bridge, N. J. His duties will cover full supervision of all research activities, a general check on manufacturing methods and sales engineering.

INTEREST

that prompts action

So intense has been the interest of readers in the series

DESIGNING MECHANICAL SPRINGS FOR MACHINE USE

by A. M. Wahl

that no sooner was it announced that copies were available in booklet form (October issue — page 12) than requests came pouring in.

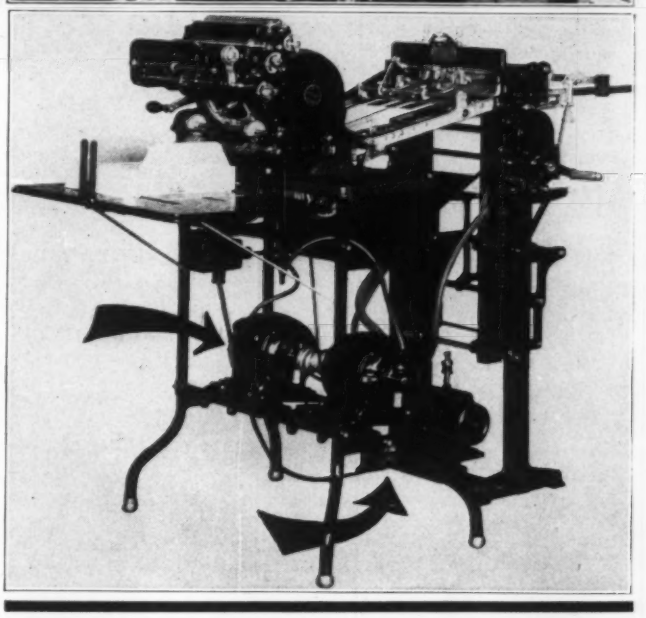
Many readers had received but one or two sample issues containing articles in the series — they wanted the whole of it. Many subscribers hesitated clipping the series from their monthly copies which they file. Others wanted the series under one cover. All of these were sufficiently interested to be prompted to write us requesting copies of the booklet.

The original supply of these reprints was exhausted some time ago. But because so many requests are still being received,

more booklets will be printed

If you have not yet requested copies for your Engineering Department, now is the time to do so. There is no charge for these booklets. Address your request to Machine Design, Penton Building, Cleveland, and copies will be sent you just as soon as we can get them in the mail.

▲ ▲ ▲ HOW BODINE MOTORS SERVE AMERICAN MULTIGRAPH MACHINES

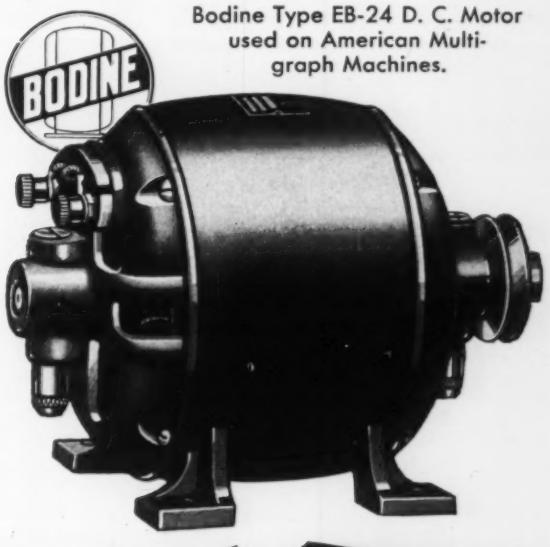


MOTOR-DRIVEN office appliances are well known to modern industry. They are important factors in the reduction of clerical overhead.

Bodine Fractional Horsepower Motors have long been used by the American Multigraph Sales Company on their multigraphing equipment. On some machines two Bodine Motors are used, one for driving the type cylinder and the other for the blower which actuates the paper feed. This double motor drive provides perfect control for the rotary press and the feeder.

Office equipment is liable to suffer from neglect and abuse even more than factory machines. It must withstand strenuous treatment in the hands of inexperienced and indifferent operators. Hence, it is not strange that Bodine Motors are used on American Multigraph Machines. Where unfailing performance is imperative, you will find Bodine Motors.

Bodine Type EB-24 D. C. Motor used on American Multigraph Machines.

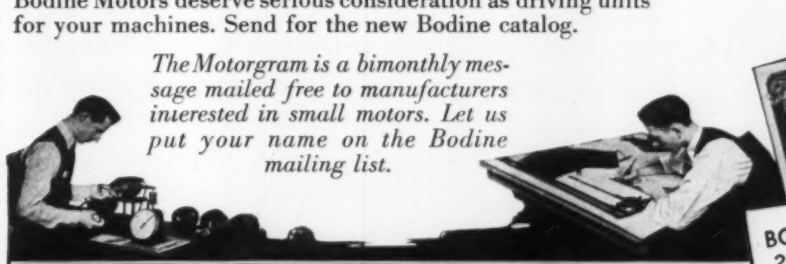


ENGINEERING SMALL MOTORS!

IN this era of severe competition, when you must provide the maximum advantages at the minimum cost, manufacturers must bear in mind that a low-priced motor is often the most expensive unit in the final analysis. No farsighted manufacturer would sacrifice the performance of his motor-driven machines by selecting motors strictly on a price basis. Bodine Motors are *engineered for your product.* They provide that extra quota of power, durability and performance which makes your machines more salable.

With ratings from 1/1300 H. P. to 1/4 H. P., at all speeds, Bodine Motors deserve serious consideration as driving units for your machines. Send for the new Bodine catalog.

The Motorgram is a bimonthly message mailed free to manufacturers interested in small motors. Let us put your name on the Bodine mailing list.



BODINE ELECTRIC CO.
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Please send items checked below:

☐ Bodine Catalog ☐ Motorgram

Name.....

Title.....

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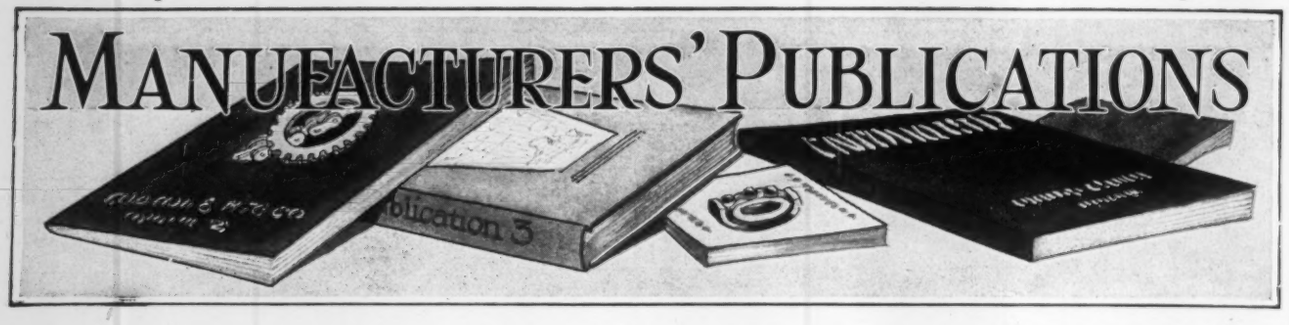
BODINE MOTORS
ENGINEERED FOR YOUR PRODUCT



Publications listed in this section may be obtained without charge from the manufacturers of the products or through MACHINE DESIGN

ROLLER BEARINGS—Shafer Bearing Corp., Chicago, in a current catalog No. 10, lists a wide range of stock mountings of its roller bearings adaptable to machine and industrial applications. It includes the recently increased range of types and sizes. The self-aligning principle is explained.

SPEED REDUCERS—Herringbone and helical speed reducers are described and illustrated in a current catalog by the Foote Bros. Gear & Machine Co., Chicago. A new rating method is used for showing horsepowers, inch pounds torque, slow and high speed revolutions per minute.

STEEL CASTINGS—Completion of its new plant for the production of electric steel castings is announced by the Kay-Brunner Steel Products Inc., Los Angeles, in a bulletin showing views of various parts of the plant.

DIE CASTINGS—A booklet by the New Jersey Zinc Co., New York, calls attention to the use of alloyed zinc for die castings. Illustrations show a variety of articles and machine parts produced by this means.

ELECTRICAL EQUIPMENT — General Electric Co., Schenectady, N. Y., has issued several bulletins on various equipment, including: Quartz-rod thermostat; squirrel-cage induction motor; crane equipment; fractional motors; direct current crane and hoist motors; synchronous motors.

CENTRIFUGAL PUMPS—Allis-Chalmers Mfg. Co., Milwaukee, in bulletin 1647 describes one type of its centrifugal pumping units. The pump and motor have been designed as a single unit rather than two units tied by a coupling. A single shaft prevents misalignment and consequent vibration and wear. Illustrations, diagrams, data tables and graphs supplement the text.

CHAIN DRIVE—A 64-page data book, No. 78, on stock chain drives recently was published by the Diamond Chain & Mfg. Co., Indianapolis. Diamond stock drives are available from ¼ to 75 horsepower, in ratios up to 8.4 to 1, and in motor speeds up to 1800 revolutions per minute. Users now can obtain immediate delivery of any drive in stock from their distributors. Complete tables, full instructions are given in the catalog, together with many interesting applications and the advantages of this high-speed drive.

ELECTRICAL PRODUCTS—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., recently issued its 1931-32 general catalogue. Containing 1352 pages, the volume presents descriptions and illustrations of the many products manufactured by this company. An interesting feature is the "instant index," which appears in the center of the book. In this index the 24 groups of equipment described are listed. An illustrated introductory section presents a brief history of the company and a discussion of interesting research developments.

INDUCTION MOTORS—Reliance Electric & Engineering Co., Cleveland, in a current bulletin covers one type of its induction motors with ball bearings for two and three-phase alternating current. Illustrations cover all details of construction and data on ratings and dimensions are given.

BALL BEARINGS—Norma-Hoffmann Bearings Corp., Stamford, Conn., just has released an interesting booklet describing its Greaseal felt-protected ball bearings, closed type. Their construction is discussed and illustrations show typical applications. Tables giving sizes and dimensions, load ratings and mounting dimensions supplement the text.

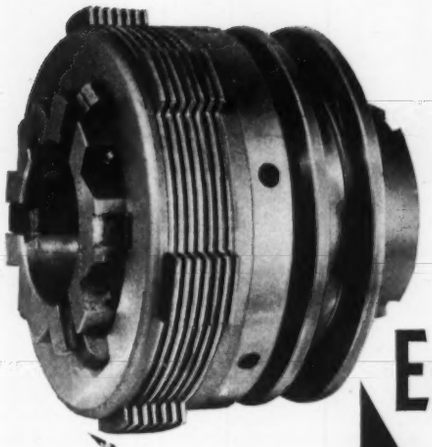
ELECTRIC HEATING UNITS—A leaflet recently was issued by Harold E. Trent Co., Philadelphia, covering its electric heating elements and units for all industrial and domestic equipments for element temperatures ranging up to 1900 degrees Fahr. The units and their application are described for the assistance of designers and others.

HEAT RESISTING ALLOY—Ohio Steel Foundry Co., Springfield, O., presents reasons for the use of its Fahrite heat-resisting alloys in current bulletin. After description of the company's facilities for production of high-grade steel the various uses of this alloy are presented. Illustrations picture a large variety of castings for widely diverse uses. A chapter gives metallurgical properties of the alloy.

NICKEL ALLOY STEEL—A buyers guide covering a tabulation of sources of supply for the more commonly used forged, rolled, cast or drawn products made from nickel steels and alloys recently was published by International Nickel Co., New York. Materials listed are the standard nickel alloy steels, nickel chromium corrosion and heat resistant steels, and special ferro-nickel alloys, not including cast iron.

SELF-TAPPING SCREWS—A booklet on fastenings has been prepared by the Parker-Kalon Corp., 200 Varick street, New York, for distribution to executives in the metal industries. The illustrations show instances in which use of these self-tapping screws have given large savings over former methods of fastening metal parts. Various types of screws are shown and their applications

(*Concluded on Page* 76)



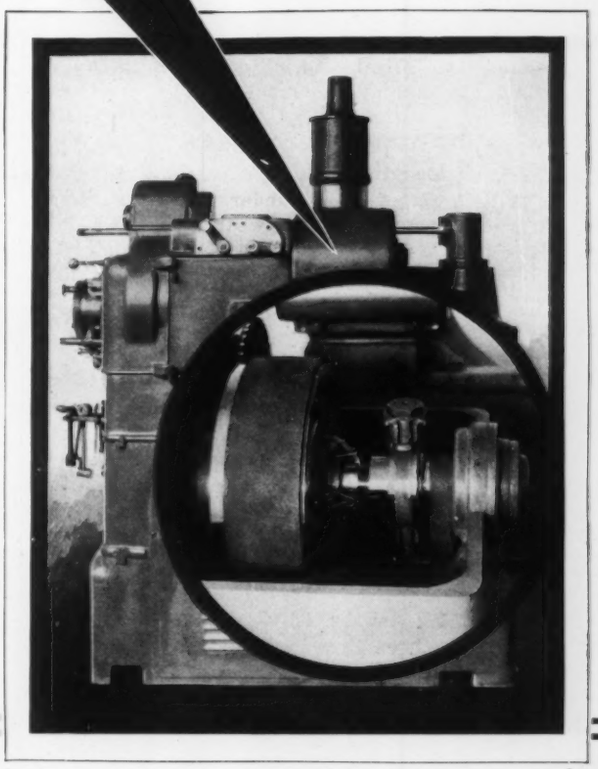
Single Close Coupled Type Twin Disc Clutch designed to run in a spray of oil. Compressed asbestos gear tooth driving plates used in place of bronze driving plates when clutch is run dry.

Especially adapted for HEAVY-DUTY PRODUCTION

PRODUCTION work on such heavy-duty service as cutting tractor and other coarse-pitch gears, demands a gear shaper simple and compact in design, yet massively constructed. The Fellows Gear Shaper Co., Springfield, Vermont, completely fulfill this demand. Their 6A-Type Gear Shaper cuts both external and internal spur and helical gears up to 18 in. pitch diameter.

Especially adaptable to motor drive . . . the machine's main drive is through a single pulley, Twin Disc Clutch, and change gear box. The starting lever engages the Twin Disc Clutch through a link connection. At the completion of the gear the machine stops automatically, the clutch being disengaged by a tripping mechanism. The simple, rigid construction of this mechanism affords great convenience in setting up the machine as the cutter can be stopped at any desired point by simply "slipping" the clutch and then stopped in that position by a brake.

Here again the designer of this machine appreciated the remarkable adaptability and unequalled compactness of the Twin Disc Clutch fully as much as its greater capacity and dependability. In addition to developing a wide range of machine tool clutch models and sizes, our Engineering Research Department understands the designer's problems. Write for specific recommendations or Engineering Data Book to *Twin Disc Clutch Company, Racine, Wisconsin.*



TWIN DISC CLUTCHES

(*Concluded from Page* 74)

discussed. The comparative studies of alternate fastening methods on basic assembly problems should be helpful and interesting to designing engineers.

PUMPS—Chicago Pump Co., 2336 Wolfram street, Chicago, has issued a bulletin on its nonclogging pumps. They are of the open-shaft type. It is fully illustrated.

RUSTLESS STEELS—Samuel Osborn & Co. Ltd., Sheffield, Eng., has issued a series of catalogs on its various grades of rustless and acid-resisting steels and irons. They include applications, manipulation, physical properties and mechanical properties.

TEMPERATURE CUTOUT—Automatic control of furnace temperature without personal attendance is discussed in a bulletin by the Hevi Duty Electric Co., Milwaukee, which suggests its cutout as a solution of the problem.

MOTOR CONTROL STARTERS—As various motor control applications require different starters Allen-Bradley Co., Milwaukee, reviews in a current bulletin its devices for this purpose and suggests some factors entering into choice of the best suited.

STEEL—A handbook of its stocks of steel has been prepared by Horace T. Potts & Co., Philadelphia, warehousemen for 115 years. This is the seventeenth edition. It covers sizes carried in stock, with price extras, weights and general information of interest to designers.

NICKEL ALLOYS—The fall issue of its buyers' guide has been issued by the International Nickel Co., New York. It is a tabulation of sources of supply for nickel steels, and special ferro-nickel alloys but does not include nickel cast iron or the nickel-bearing nonferrous metals.

CHAIN—A processed malleable iron chain developed by the Link-Belt Co., Chicago, under the name Promal, giving high tensile strength and wear resistance is the subject of a recent data book No. 1050, issued by that company. It contains full data on this chain, its links, attachments and various uses. Dimensions, strength, list prices and weights are included.

WROUGHT IRON—A bulletin on characteristics and application of wrought iron is being circulated by the Wrought Iron Research association, Pittsburgh. It gives pictorial and textual information on wrought iron, with microphotographic illustrations, showing structure of the metal, and charts and tables covering its physical properties.

ELECTRICAL EQUIPMENT—General Electric Co., Schenectady, N. Y., has issued recent bulletins as follows: Atomic-hydrogen arc welding equipment, mechanical-drive turbines, semi-automatic reduced-voltage starters, thermostats, selsyns, synchronous motors, automatic full-voltage controllers, oil circuit breakers, photo electric relays, air drawing-oven, hydraulic operators, and automotive switching equipment.

TRANSFORMERS—A six-range, metal-clad portable current transformer is described in a current bulletin by the Esterline-Angus Co., Indianapolis. Illustrations and charts supplement the text.

NONFERROUS ALLOYS—A looseleaf booklet on standard nonferrous casting alloys has been issued by William H. Barr Inc., Buffalo. It contains accurate information and is designed primarily as a reference for engineers and machine designers.

AUTOMATIC CONTROL—A panorama of industrial progress in modern process control methods is presented in a booklet issued by the Brown Instrument Co., Philadelphia. It is fully illustrated to show application to various industries and results obtained by use of the company's devices.

INGOT IRON—Savings possible in the coal industry by use of its ingot iron form the subject of a booklet by the American Rolling Mill Co., Middletown, O. Less liability to rust deterioration is the basis of claims for economy in use of this material. Illustrations show installations of ingot iron and data as to savings are given.

STEEL SPECIFICATIONS—A reprint from the report of the iron and steel division of the Society of Automotive engineers has been issued by the International Nickel Co., New York, containing standard specifications for steels. This gives greater distribution of these important data.

TRUCK-TYPE SWITCHGEAR—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has issued a catalog on its metal enclosed truck-type switchgear, manually and electrically operated, built for three-phase, 60-cycle supply, 3000 amperes maximum and 15,000 watts maximum. All high-voltage circuits are enclosed, affording safety to the operator.

ACID PROOFING—American Hard Rubber Co., New York, has issued a catalog describing uses for its hard rubber lining process for protecting metal containers from the action of acids and other corrosives in the chemical process industries. Tanks, pipes, pumps and other equipment lined with hard rubber for protection are among the uses illustrated. Illustrations, data tables and charts supplement the text.

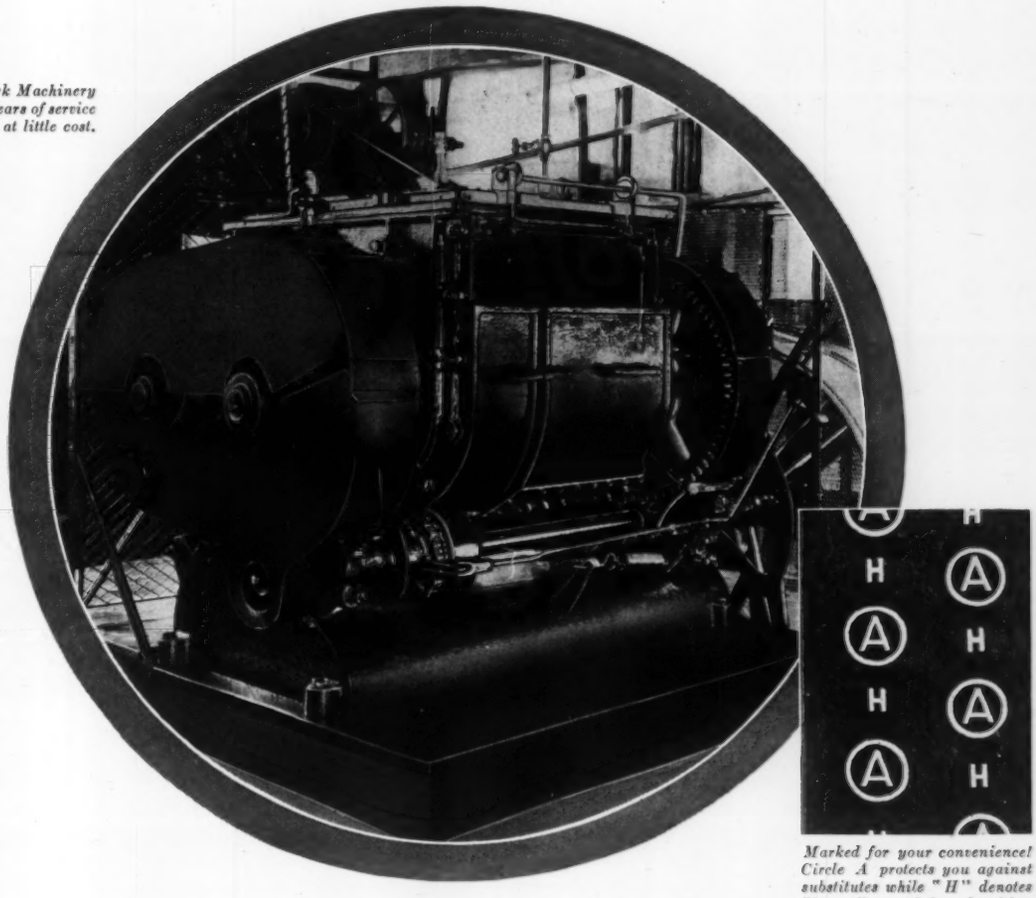
RESISTANCE THERMOMETERS—A revised catalog of its resistance thermometers is being sent out by Leeds & Northrup Co., Philadelphia. It covers resistance thermometers for recording, controlling and indicating temperatures. The catalog goes into applications for heating and ventilating, use in refrigerating and chemical plants, gas making and other comparatively low temperature uses.

METAL HARDNESS—A booklet giving data for comparing metal hardness with various scales has been issued by the Lindberg Steel Treating Co., Chicago. It contains conversion tables covering monotron, scleroscope, Rockwell and brinell indications. A color chart shows temperatures at which tools should be drawn. Other data valuable to engineers is included. The book sells for $1 and is free to users of the company's service.

YOUR HEAVIEST MACHINES

can be cork-isolated at a relatively small cost

Armstrong's Cork Machinery Isolation adds years of service to this machine at little cost.



Marked for your convenience! Circle A protects you against substitutes while "H" denotes "heavy," one of three densities.

CORK-CUSHIONING easily absorbs the vibration and noise of moving machinery. But no more easily than your budget can absorb the cost of this important plant item. How much does this cushioning—Armstrong's Cork Machinery Isolation—actually cost? You'll find the cost is remarkably low, even for your biggest, heaviest machines. And for lighter, smaller machines, the expense is still more moderate.

Results, though, are important and permanent. Since Armstrong's Cork Machinery Isolation adequately absorbs vibration and noise, the muffled machine is protected. Nearby machines are shielded. The building structure is saved from constant shaking. And the efficiency of employees is materially increased.

All these improvements are permanent. Since cork, under the heaviest compression, takes no "set," the resiliency of Armstrong's Cork Machinery Isolation is retained even after years of service. It does not disintegrate or deteriorate. For your convenience it is made in three densities and seven thicknesses. So you can order cork-cushioning to meet your special needs for practically any moving machinery.

Armstrong's Cork Machinery Isolation has other interesting uses in office, factory, apartment house, or hospital. We'll be pleased to tell you about these. Of course, our engineers will be glad to consult with you on special problems. For complete information, write to: Armstrong Cork & Insulation Co., 943 Concord St., Lancaster, Penna.

Armstrong's (A) Product

Armstrong's Cork Machinery Isolation

Muffle These for Life

Armstrong's Cork Machinery Isolation can isolate, with extremely satisfactory results: air compressors, blowers, drill presses, drop hammers, elevator hoists, engines, fans, forging machines, machine tools, motors, motor generators, printing presses, pumps, punching machines, refrigerating machines, vacuum cleaners, and similar apparatus.

Business Announcements and Sales Briefs

APPOINTMENT of C. L. Hull as sales manager of the Detroit division of the Square D Co., recently was announced by L. W. Mercer, vice president and general manager. T. B. Martin is retained as sales manager of the Industrial Controller division of the Square D Co., with offices and factory at Milwaukee.

* * *

Universal Gear Corp., 327 S. LaSalle street, Chicago, manufacturer of heliocentric and revocentric speed reducers, the Pitter clutch, etc., recently announced the appointment of John C. Phelps as sales manager. Fred M. Potgieter continues in charge as vice president and general manager.

* * *

John J. Berliss, treasurer, Roller Bearing Co. of America, Trenton, N. J., for the past 20 years, has also been elected general manager. Carl A. Johnson, formerly identified with Hyatt Roller Bearing Co., Newark, N. J., has been appointed director of sales.

* * *

B. L. Donahue, identified with Pittsburgh office, Cutler-Hammer Inc., Milwaukee, for the past eight years, has been appointed Buffalo district office manager, succeeding B. A. Hansen, resigned.

* * *

Polson Mfg. Co., Buffalo, has been sold to the Great Lakes Pressed Steel Corp., Buffalo. The Great Lakes company will continue production of the metal specialties manufactured by the Polson company.

* * *

Driver-Harris Co., Harrison, N. J., recently secured from the Krupp Nirosta Co., Watervliet, N. Y., a license to produce "Krupp-Nirosta" steel in castings, sheets, rods, strip and wire.

* * *

W. D. Cameron recently was appointed manager of the Detroit office of the General Electric Co., Schenectady, N. Y., to succeed the late J. H. Livsey. Since 1927 Mr. Cameron has been assistant manager of the Detroit office.

* * *

Ex-Cell-O Aircraft & Tool Corp., Detroit, has added a department for the manufacture of broaches and accessory fixtures. Gages for checking broached parts will also be made.

* * *

American Metal Products Co., Milwaukee, has opened a district sales office at 327 Exchange National Bank building, Tulsa, Okla. C. A. Fulmer is in charge.

* * *

Ralph M. Bowman has been appointed purchasing agent, Republic Steel Corp., Youngstown, O., to succeed W. J. Mussman, resigned. Mr. Bowman formerly was purchasing agent, Central Alloy Steel Corp., Massillon, O., and more recently was buyer in charge of raw materials for the Republic corporation. C. A. Ilgenfritz is director of purchases.

* * *

Eureka Electric Equipment Co., North East, Pa., has taken over the commutator manufacturing business which formerly was handled by the Eureka Metal Products Co.

* * *

Harold Clark, of White, Weld & Co., Detroit, has been elected a director of L. A. Young Spring & Wire Corp., Detroit, to succeed J. Mitchell Hoyt.

* * *

Ohio Electric Mfg. Co. is the new name for Ohio Electric & Controller Co., 5900 Maurice avenue, Cleveland, manufacturer of lifting magnets and small motors.

* * *

New York Central railroad is inquiring for 50 large Hudson type locomotives. This is the largest inquiry for locomotives issued this year and involves approximately $5,000,000.

* * *

Knapp-Monarch Co., St. Louis, manufacturer of household appliances, has purchased the former plant of National Carbon Co., at Belleville, Ill., across the river from St. Louis, and will move its factory from Webster City, Iowa, to the new location.

* * *

Complete charge of the Chicago branch of the Ohmer Fare Register Co., Dayton, O., recently was assumed by B. C. Palmer, special sales engineer for that firm since 1927. He contributed largely to the successful development of the company's taximeters.

* * *

Thomas & Skinner Steel Products Co., Indianapolis, has purchased the sheet steel warehouse stock of the Follansbee Bros. Co., Pittsburgh, at Indianapolis. E. C. Folkening, who has been with Follansbee for the past 25 years, will continue as district sales manager. Thomas & Skinner has been named Indiana distributor for the Simonds Saw & Steel Co., Lockport, N. Y.

* * *

Mueller Engineering Co., Racine, Wis., has been bought by the Hein-Werner Motor Parts Corp., Waukesha, Wis., and equipment of the Racine plant is being transferred to Waukesha. The Hein-Werner company, which is closely allied with the Waukesha Motor Co., plans an addition to be ready March 1. J. J. Mueller and D. J. Mueller of the Racine company are joining the Hein-Werner engineering staff.

A few pieces of DIETZGEN Modern Drafting Room Furniture

Shamrock Adjustable Drawing Tables—Furnished in the many standard sizes of tops.

Ideal Adjustable Drawing Tables—Furnished with the many standard sizes of boards.

Sturdy Drawing Tables—With Adjustable Tops in the standard sizes.

Sturdy Drawing Tables—With Adjustable or Solid Tops in the standard sizes.

Steel Sectional Filing Cases—Made of cold rolled furniture steel, welded corners eliminate joints. Practically indestructible—fireproof.

Draftsmen's Stools—Wood and Steel. Everhold Automatic Extension Stool with leather cover and footrest. Draftsman's Stool with golden elm wood seat.

"You think we should turn out more work . . . . . of course we should

"We can turn out more . . . and **better work** but not until we first junk some of this antiquated equipment. We've got as capable a staff of draftsmen as you'll find anywhere. But working eight hours a day on wobbly antiquated equipment, doing extremely exacting work is certainly **not** inspiring and it is extremely difficult. It's hard on the nerves . . . makes best work impossible . . . slows production.

"Give them some new solid, substantial drafting furniture, modern in every way, and you'll have better work—in less time."

* * *

Dietzgen is one of the largest distributors of drafting room furniture in the country. It will pay you to investigate our complete line of modern drafting room equipment.

EUGENE DIETZGEN CO.

Enduring worth at reasonable cost

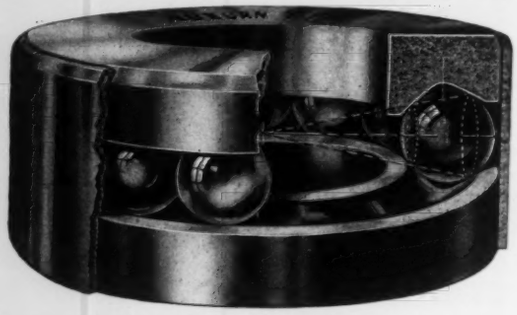
Chicago New York Philadelphia Washington
New Orleans Pittsburgh Milwaukee Los Angeles
San Francisco *Factory at Chicago*

DIETZGEN ESTABLISHED 1865

Manufacturers of Drafting and Surveying Supplies

DESIGN FEATURES

which assure better Machine operation



FOUR POINT CONE PRINCIPLE assures races maintaining correct relative location for any position of the shaft.

DUST PROTECTION through the outside band assures longer bearing life.

SELF-CONTAINED The races and balls are held together as a unit, assuring correct assembly on the machine.

OTHER FEATURES are described in Data Sheets 1a-12a. Write for a set to put in your reference files.

STEEL, BRONZE, MONEL AND ALUMINUM BALLS

AUBURN BALL BEARING CO., 59 Clarissa St., ROCHESTER, N.Y.

AUBURN

WHY MECHANIZE MATHEMATICS?

BECAUSE — by so doing you can delegate your problems to lieutenants and their results when presented to you will be clear, concise, to slide rule accuracy, visua ized and readily understandable.

The determination of stresses and material distributon to withstand them become evident through Integraph Equipment.

Have You a Son Struggling With Calculus?

Integraph Equipment and "The Mechanics of the Calculus" as a present would make this Christmas one he would never forget because *He can do it with the Integraph* and understand it too.

THE INTEGRAPH CO.

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MACHINE DESIGN is a monthly technical publication conceived, edited and directed expressly for those executives and engineers responsible for the creation and improvement of machines built for sale, and for the selection of the materials and parts to be used.

FORETELLING

the performance of that new machine

SOONER or later, expanding business or changing processes will cause you to buy a new type of machine . . . one which has never been tested in your plant. How can you know in advance that it will prove as profitable and efficient as its makers claim?

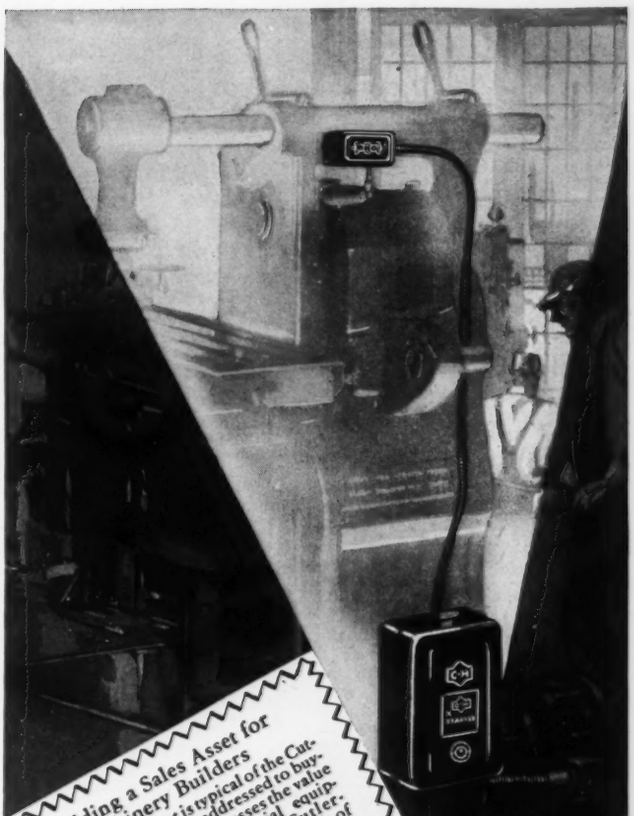
On machines driven by electric motors there is a safeguard to your judgment, a guide-mark to look for. This mark is . . . Cutler-Hammer Motor Control. If you find it on this motor-driven machine, it is a good indication that the builder has done his best regardless of cost to safeguard the performance of his machine . . . to insure that its motor produces to the utmost safe limit . . . to protect the motor against dangerous overloads . . . to assure easy, convenient time-and-step-saving operation.

Cutler-Hammer Motor Control is furnished as standard equipment in a constantly increasing number of successful motor-driven machines. Any machine builder will furnish it on request. It is also available as well for every motor in your plant, whether the motor is part of a machine or a separate unit. Leading motor builders recommend C-H Control; reputable electrical wholesalers carry it in stock.

CUTLER-HAMMER, Inc.

Pioneer Manufacturers of Electric Control Apparatus

1282 St. Paul Avenue MILWAUKEE, WISCONSIN



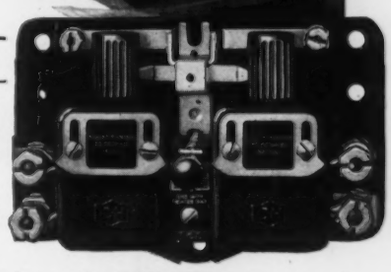
Building a Sales Asset for Machinery Builders

This advertisement is typical of the Cutler-Hammer campaign addressed to buyers of your machines. It stresses the value of Motor Control on industrial equipment—builds acceptance for Cutler-Hammer Motor Control as a mark of good machines—creates a ready-made sales asset for you. Every month your customers are told this story in the American Machinist, Electrical World, Mill & Factory & Industrial Management. An interlocking campaign also appears in the Saturday Evening Post, Nation's Business, Time and Electrical World.

MORE USABLE H. P.

So accurately does the Cutler-Hammer Thermal Overload Relay protect motors against overloads that heavier loads are handled with safety. And its accuracy is permanent.

Nothing to replace after tripping . . . just press reset button to put motor back in service. It is used on the entire C-H Line of Automatic Starters.

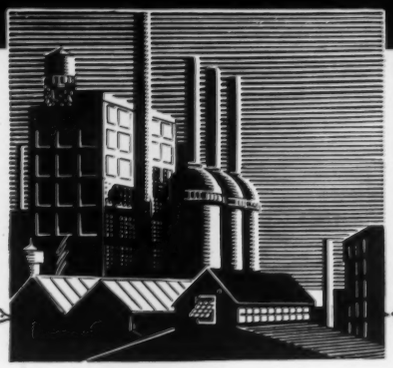


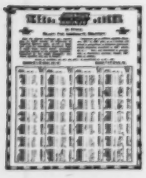
CUTLER HAMMER

The Control Equipment Good Electric Motors Deserve

(A-233)

By all means EXPERIMENT





The Johnson Bronze Line of General Purpose Bronze Bushings is listed on a handy and convenient Wall Card reproduced here. The listing includes over 600 distinct sizes and types. A copy will be supplied on request without obligation.

CHANGE brings progress, providing the change is for the better. Only careful research and experiment can determine the point. ▲▲▲ So, before you change so important a part as a bearing, make sure that the change improves the efficiency and salability of your product to a readily perceptible degree. You can ill afford a change of bearing without experiment—without practical testing. ▲▲▲ For years, more bronze bearings have been used thruout industry than any other kind, because actual performance shows them to be efficient and economical. ▲▲▲ By all means experiment, but do not discard a bronze bearing until you have found a better bearing to take its place.

JOHNSON BRONZE COMPANY, NEW CASTLE, PA.

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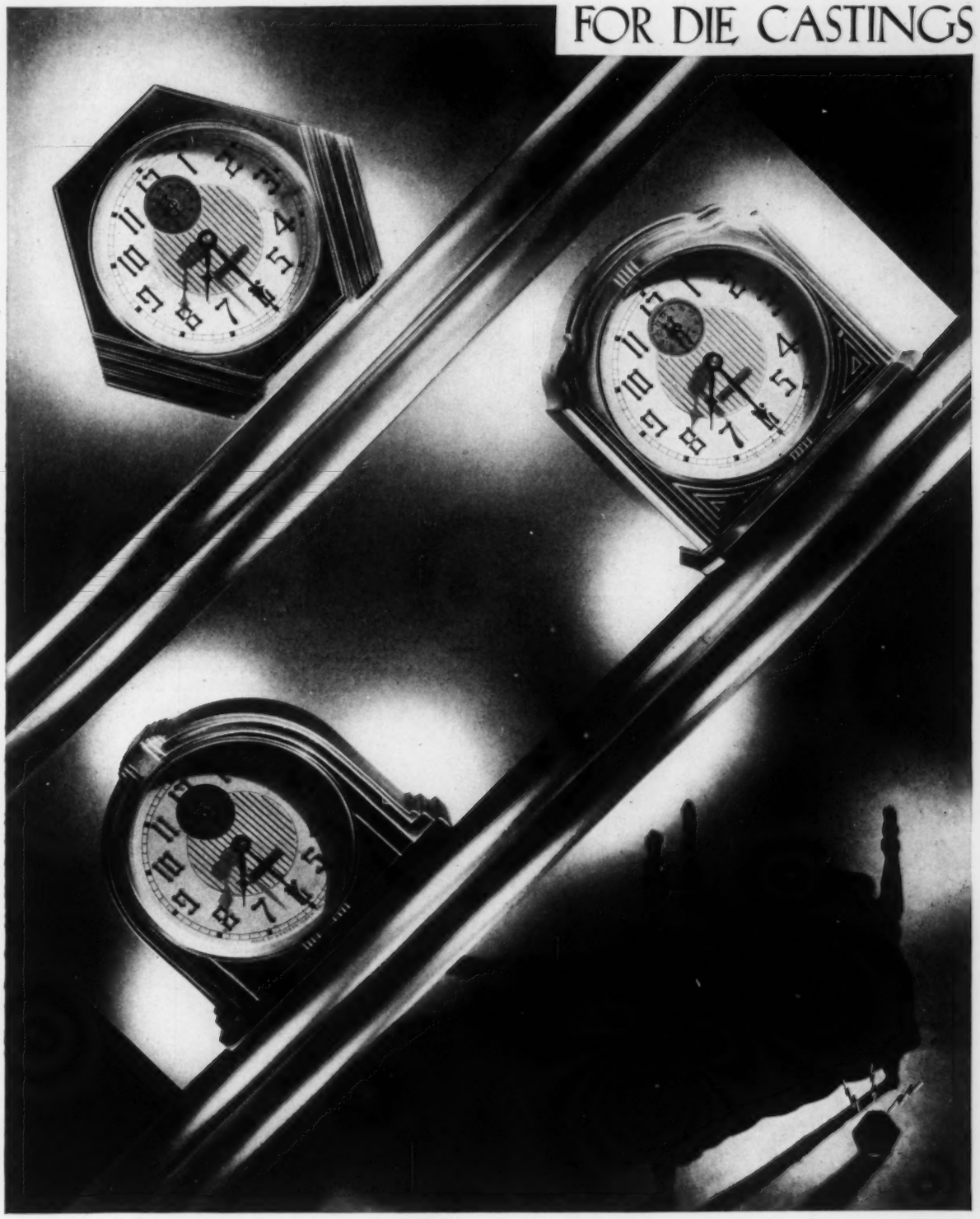
BUSHINGS **BEARINGS** **BAR BRONZE**

HORSE HEAD *UNIFORM QUALITY* ZINC

FOR DIE CASTINGS



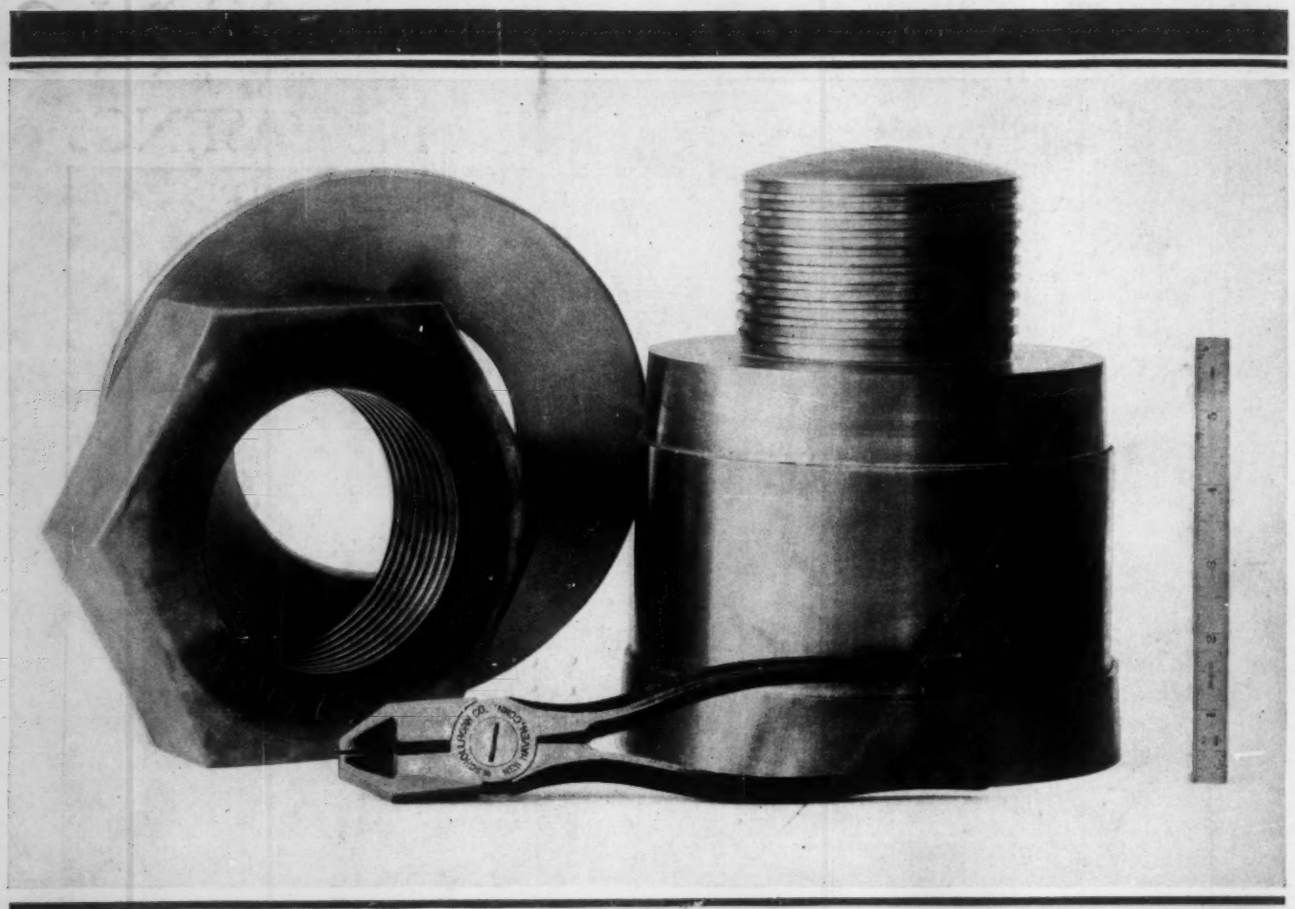
New cases for a leading alarm clock, die cast from an alloy of Horse Head Zinc. Butler Silver Finish.

Combining ACCURACY of dimension, FLEXIBILITY of design, BEAUTY of finish, SPEED of production.

THE NEW JERSEY ZINC COMPANY

160 FRONT STREET, NEW YORK CITY

Zinc Metal and Alloys - *Rolled Zinc* - *Zinc Pigments* - *Sulphuric Acid* - *Spiegeleisen*



from pivot screws for pliers to giant locomotive side-rod pins

DARDELET THREADLOCK

IS FILLING THE NEEDS OF INDUSTRY FOR SCREW THREADED FASTENINGS WHICH WILL HOLD ABSOLUTELY TIGHT UNDER ALL SERVICE CONDITIONS.

THE DARDELET SELF-LOCKING SCREW THREAD IS PROTECTED BY PATENTS AND IS MANUFACTURED IN THE UNITED STATES UNDER LICENSE FROM THE DARDELET THREADLOCK CORPORATION

If you have trouble in keeping threaded fastenings tight, write us

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